

AMENDMENT OF SOLICITATION/MODIFICATION OF CONTRACT			1. CONTRACT ID CODE N/A	PAGE 1 OF 32
2. AMENDMENT/MODIFICATION NO. 0003	3. EFFECTIVE DATE JUL.29, 2002	4. REQUISITION/PURCHASE REQ. NO. N/A	5. PROJECT NO. (If applicable) SPEC. NO. 1214	
6. ISSUED BY CODE		7. ADMINISTERED BY (If other than Item 6) CODE		
DEPARTMENT OF THE ARMY U.S. ARMY ENGINEER DISTRICT, SACRAMENTO SACRAMENTO, CALIFORNIA 95814-2922		DEPARTMENT OF THE ARMY US ARMY CORPS OF ENGINEERS, LOS ANGELES DISTRICT P.O. BOX 532711 LOS ANGELES, CALIFORNIA 90053-2325		

8. NAME AND ADDRESS OF CONTRACTOR (No., street, county, State and ZIP Code)		(√)	9A. AMENDMENT OF SOLICITATION NO. DACA05-02-B-0004
		×	9B. DATED (SEE ITEM 11) N/A
			10A. MODIFICATION OF CONTRACTS/ORDER NO. N/A
			10B. DATED (SEE ITEM 13) N/A
CODE	FACILITY CODE		

11. THIS ITEM ONLY APPLIES TO AMENDMENTS OF SOLICITATIONS

☒ The above numbered solicitation is amended as set forth in Item 14. The hour and date specified for receipt of Offers ☐ is extended, ☒ is not extended.

Offers must acknowledge receipt of this amendment prior to the hour and date specified in the solicitation or as amended, by one of the following methods:

(a) By completing Items 8 and 15, and returning 1 copies of the amendment; (b) By acknowledging receipt of this amendment on each copy of the offer submitted; or (c) By separate letter or telegram which includes a reference to the solicitation and amendment numbers. FAILURE OF YOUR ACKNOWLEDGMENT TO BE RECEIVED AT THE PLACE DESIGNATED FOR THE RECEIPT OF OFFERS PRIOR TO THE HOUR AND DATE SPECIFIED MAY RESULT IN REJECTION OF YOUR OFFER. If by virtue of this amendment you desire to change an offer already submitted, such change may be made by telegram or letter, provided each telegram or letter makes reference to the solicitation and this amendment, and is received prior to the opening hour and date specified.

12. ACCOUNTING AND APPROPRIATION DATA (If required) N/A	NOTE: ITEM 13 BELOW IS N/A.
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13. THIS ITEM APPLIES ONLY TO MODIFICATIONS OF CONTRACTS/ORDERS, IT MODIFIES THE CONTRACT/ORDER NO. AS DESCRIBED IN ITEM 14.

(√)	A. THIS CHANGE ORDER IS ISSUED PURSUANT TO: (Specify authority) THE CHANGES SET FORTH IN ITEM 14 ARE MADE IN THE CONTRACT ORDER NO. IN ITEM 10A. N/A
	B. THE ABOVE NUMBERED CONTRACT/ORDER IS MODIFIED TO REFLECT THE ADMINISTRATIVE CHANGES (such as changes in paying office, appropriation date, etc.) SET FORTH IN ITEM 14, PURSUANT TO THE AUTHORITY OF FAR 43.103(b).
	C. THIS SUPPLEMENTAL AGREEMENT IS ENTERED INTO PURSUANT TO AUTHORITY OF:
	D. OTHER (Specify type of modification and authority) N/A

E. IMPORTANT: Contractor ☐ is not, ☐ is required to sign this document and return _____ copies to the issuing office.

14. DESCRIPTION OF AMENDMENT/MODIFICATION (Organized by UCF section headings, including solicitation/contract subject matter where feasible.) FIRE/CRASH RESCUE STATION MARCH AFB, CA.

2 Encl

- Revised Pages: Frontend (Page 165A), Section 13851(New), Section 16375 (Revised)
- Revised Drawings: E1.00, E.3.00, E6.00, E6.01, E8.00, E12.0

Except as provided herein, all terms and conditions of the document referenced in Item 9A or 10A, as heretofore changed, remains unchanged and in full force and effect.

15A. NAME AND TITLE OF SIGNER (Type or print) e		16A. NAME AND TITLE OF CONTRACTING OFFICER (Type or print)	
15B. CONTRACTOR/OFFEROR (Signature of person authorized to sign)	15C. DATE SIGNED	16B. UNITED STATES OF AMERICA BY (Signature of Contracting Officer)	16C. DATE SIGNED

52.225-13 RESTRICTIONS ON CERTAIN FOREIGN PURCHASES (JUL 2000)

(a) The Contractor shall not acquire, for use in the performance of this contract, any supplies or services originating from sources within, or that were located in or transported from or through, countries whose products are banned from importation into the United States under regulations of the Office of Foreign Assets Control, Department of the Treasury. Those countries are Cuba, Iran, Iraq, Libya, North Korea, Sudan, the territory of Afghanistan controlled by the Taliban, and Serbia (excluding the territory of Kosovo).

(b) The Contractor shall not acquire for use in the performance of this contract any supplies or services from entities controlled by the government of Iraq.

(c) The Contractor shall insert this clause, including this paragraph (c), in all subcontracts.

52.236-4 PHYSICAL DATA (APR 1984)

Data and information furnished or referred to below is for the Contractor's information. The Government shall not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.

(a) The indications of physical conditions on the drawings and in the specifications are the result of site investigations by the Government.

(b) Weather conditions : The Contractor shall satisfy himself/herself as to the hazards likely to arise from weather conditions. Complete weather records and reports may be obtained from any US Weather Bureau Office.

(c) Transportation facilities: The Contractor shall make his/her own investigation of the conditions of existing public and private roads and of clearances, restrictions, bridge load limits and other limitations affecting transportation and ingress and egress at the job site. The unavailability of transportation facilities or limitations thereon shall not become a basis for transportation facilities or limitations thereon shall not become a basis for claims against the Government or extension of time for completion of the work.

252.247-7024 NOTIFICATION OF TRANSPORTATION OF SUPPLIES BY SEA (MAR 2000)

(a) The Contractor has indicated by the response to the solicitation provision, Representation of Extent of Transportation by Sea, that it did not anticipate transporting by sea any supplies. If, however, after the award of this contract, the Contractor learns that supplies, as defined in the Transportation of Supplies by Sea clause of this contract, will be transported by sea, the Contractor --

(1) Shall notify the Contracting Officer of that fact; and

(2) Hereby agrees to comply with all the terms and conditions of the Transportation of Supplies by Sea clause of this contract.

(b) The Contractor shall include this clause; including this paragraph (b), revised as necessary to reflect the relationship of the contracting parties--

(1) In all subcontracts under this contract, if this contract is a construction contract; or

(2) If this contract is not a construction contract, in all subcontracts under this contract that are for--

(i) Noncommercial items; or

(ii) Commercial items that--

(A) The Contractor is reselling or distributing to the Government without adding value (generally, the Contractor does not add value to items that it subcontracts for f.o.b. destination shipment);

(B) Are shipped in direct support of U.S. military contingency operations, exercises, or forces deployed in humanitarian or peacekeeping operations; or

(C) Are commissary or exchange cargoes transported outside of the Defense Transportation System in accordance with 10 U.S.C. 2643.

(End of clause)

SECTION TABLE OF CONTENTS
DIVISION 13 - SPECIAL CONSTRUCTION
SECTION 13851A
FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 GENERAL REQUIREMENTS
 - 1.3.1 Standard Products
 - 1.3.2 Nameplates
 - 1.3.3 Keys and Locks
 - 1.3.4 Tags
 - 1.3.5 Verification of Dimensions
 - 1.3.6 Compliance
 - 1.3.7 Qualifications
 - 1.3.7.1 Engineer and Technician
 - 1.3.7.2 Installer
- 1.4 SYSTEM DESIGN
 - 1.4.1 Operation
 - 1.4.2 Operational Features
 - 1.4.3 Alarm Functions
 - 1.4.4 Primary Power
 - 1.4.5 Battery Backup Power
 - 1.4.6 Interface With other Equipment
- 1.5 TECHNICAL DATA AND COMPUTER SOFTWARE
- 1.6 DELIVERY AND STORAGE

PART 2 PRODUCTS

- 2.1 CONTROL PANELS BOTH MAIN AND REMOTE
 - 2.1.1 Remote Control Panel (Small Version)
 - 2.1.2 Circuit Connections
 - 2.1.3 System Expansion and Modification Capabilities
 - 2.1.3.1 ADDRESSABLE MODULES
 - 2.1.4 Addressable Control Module
 - 2.1.5 Addressable Initiating Device Circuits Module
- 2.2 STORAGE BATTERIES
- 2.3 BATTERY CHARGER
- 2.4 ADDRESSABLE MANUAL FIRE ALARM STATIONS
- 2.5 FIRE DETECTING DEVICES
 - 2.5.1 Heat Detectors
 - 2.5.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors
 - 2.5.2 Smoke Detectors
 - 2.5.2.1 Ionization Detectors
 - 2.5.2.2 Photoelectric Detectors
 - 2.5.2.3 Projected Beam Smoke Detectors
 - 2.5.2.4 Duct Detectors
 - 2.5.3 Combination Smoke and Heat Detectors
- 2.6 AUDIO\VISUAL NOTIFICATION APPLIANCES
- 2.7 AUDIBLE NOTIFICATION APPLIANCES
 - 2.7.1 Alarm Bells And Chimes
 - 2.7.2 Alarm Horns
 - 2.7.3 Visual Notification Appliances
 - 2.7.4 Voice Evacuation System
- 2.8 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT
 - 2.8.1 Conduit
 - 2.8.2 Wiring
 - 2.8.3 Special Tools and Spare Parts

PART 3 EXECUTION

- 3.1 INSTALLATION
 - 3.1.1 Power Supply for the System
 - 3.1.2 Wiring
 - 3.1.3 Control Panels
 - 3.1.4 Detectors
 - 3.1.5 Notification Appliances
 - 3.1.6 Annunciator Equipment
 - 3.1.7 Addressable Initiating Device Circuits Module
 - 3.1.8 Addressable Control Module
- 3.2 OVERVOLTAGE AND SURGE PROTECTION
 - 3.2.1 Power Line Surge Protection
 - 3.2.2 Low Voltage DC Circuits Surge Protection
 - 3.2.3 Signal Line Circuit Surge Protection
- 3.3 GROUNDING
- 3.4 TESTING
 - 3.4.1 Preliminary Tests
 - 3.4.2 Acceptance Test
- 3.5 TRAINING

-- End of Section Table of Contents --

SECTION 13851A

FIRE DETECTION AND ALARM SYSTEM, ADDRESSABLE

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI S3.41 (1990; R 1996) Audible Emergency Evacuation Signals

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

47 CFR 15 Radio Frequency Devices

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a (1998) Approval Guide Fire Protection

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41 (1991; R 1995) Surge Voltages in Low-Voltage AC Power Circuits

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

NFPA 72 (1996; Errata Oct 96, Dec 96; TIA 96-1, 96-2, 96-3) National Fire Alarm Code

NFPA 90A (1996) Installation of Air Conditioning and Ventilating Systems

NFPA 1221 (1994) Installation, Maintenance and Use of Public Fire Service Communication Systems

UNDERWRITERS LABORATORIES (UL)

UL 6 (1997) Rigid Metal Conduit

UL 38 (1994; Rev Nov 1994) Manually Actuated Signaling Boxes for Use with Fire-Protective Signaling Systems

UL 228 (1997) Door Closers-Holders, With or Without Integral Smoke Detectors

UL 268 (1996; Rev thru Jun 1998) Smoke Detectors for Fire Protective Signaling Systems

UL 268A (1998) Smoke Detectors for Duct Applications

UL 464 (1996; Rev May 1997) Audible Signal Appliances

UL 521 (1993; Rev Oct 1994) Heat Detectors for Fire Protective Signaling Systems

UL 632 (1994; Rev Sep 1994) Electrically-Actuated Transmitters

UL 797 (1993; Rev thru Mar 1997) Electrical Metallic Tubing

UL 864 (1996) Control Units for Fire-Protective Signaling Systems

UL 1242 (1996; Rev Mar 1998) Intermediate Metal Conduit

UL 1971 (1995; Rev thru May 1997) Signaling Devices for the Hearing Impaired

1.2 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Fire Alarm Reporting System; FIO{____}, {____}

Detail drawings, prepared and signed by a Registered Professional Engineer or a NICET Level {3}-{4} Fire Alarm Technician, consisting of a complete list of equipment and material, including manufacturer's descriptive and technical literature, catalog cuts, and installation instructions. Note that the contract drawings show layouts based on typical detectors. The Contractor shall check the layout based on the actual detectors to be installed and make any necessary revisions in the detail drawings. The detail drawings shall also contain complete wiring and schematic diagrams for the equipment furnished, equipment layout, and any other details required to demonstrate that the system has been coordinated and will properly function as a unit. Detailed point-to-point wiring diagram shall be prepared and signed by a Registered Professional Engineer or a NICET Level {3}-{4} Fire Alarm Technician showing points of connection. Diagram shall include connections between system devices, appliances, control panels, supervised devices, and equipment that is activated or controlled by the panel.

SD-03 Product Data

Storage Batteries; FIO{____}, {____}

Substantiating battery calculations for supervisory and alarm power requirements. Ampere-hour requirements for each system component and each panel component, and the battery recharging period shall be included.

Voltage Drop; FIO{____}, {____}

Voltage drop calculations for notification appliance circuits to indicate that sufficient voltage is

available for proper appliance operation.

Special Tools and Spare Parts; FIO[____], [____]

Spare parts data for each different item of material and equipment specified, not later than {3}-[2] months prior to the date of beneficial occupancy. Data shall include a complete list of parts and supplies with the current unit prices and source of supply and a list of the parts recommended by the manufacturer to be replaced after {1}-[____] year or first two years of service.

Technical Data and Computer Software; G, [FIO____]

Technical data which relates to computer software.

Training; FIO[____], [____]

Lesson plans, operating instructions, maintenance procedures, and training data, furnished in manual format, for the training courses. The operations training shall familiarize designated government personnel with proper operation of the fire alarm system. The maintenance training course shall provide the designated government personnel adequate knowledge required to diagnose, repair, maintain, and expand functions inherent to the system.

Testing; GA[____], [____]

Detailed test procedures, prepared and signed by a Registered Professional Engineer or a NICET Level {3}-[4] Fire Alarm Technician, for the fire detection and alarm system {60}-[____] days prior to performing system tests.

SD-06 Test Reports

Testing; FIO[____], [____]

Test reports, in booklet form, showing field tests performed to prove compliance with the specified performance criteria, upon completion and testing of the installed system. Each test report shall document actual readings, test results and indicate the final position of controls. The Contractor shall include the NFPA 72 Certificate of Completion and NFPA 72 Inspection and Testing Form, with the appropriate test reports.

SD-07 Certificates

Equipment; FIO[____], [____]

Certified copies of current approvals or listings issued by an independent test lab if not listed by UL, FM or other nationally recognized testing laboratory, showing compliance with specified NFPA standards.

Qualifications; FIO[____], [____]

Proof of qualifications for required personnel. The installer shall submit proof of experience for the Professional Engineer, fire alarm technician, and the installing company.

SD-10 Operation and Maintenance Data

Technical Data and Computer Software; FIOG, [____]

{Six}-[____] copies of operating manual outlining step-by-step procedures required for system startup, operation, and shutdown. The manual shall include the manufacturer's name, model number, service manual, parts list, and complete description of equipment and their basic operating features. {Six}-[____] copies of maintenance manual listing routine maintenance procedures, possible breakdowns and repairs, and troubleshooting guide. The manuals shall include conduit layout, equipment layout and simplified wiring, and control diagrams of the system as installed. The manuals shall include complete procedures for system revision and expansion, detailing both equipment and software requirements. Original and backup copies of all software delivered for this project shall be provided, on each type of media utilized. Manuals shall be approved prior to training.

1.3 GENERAL REQUIREMENTS

1.3.1 Standard Products

Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products for at least {2}-[____] years prior to bid opening. Equipment shall be supported by a service organization that can provide service within 24 hours of notification.

1.3.2 Nameplates

Major components of equipment shall have the manufacturer's name, address, type or style, voltage and current rating, and catalog number on a noncorrosive and nonheat-sensitive plate which is securely attached to the equipment.

1.3.3 Keys and Locks

Locks shall be keyed alike. Four keys for the system shall be provided.

1.3.4 Tags

Tags with stamped identification number shall be furnished for keys and locks.

1.3.5 Verification of Dimensions

After becoming familiar with details of the work, the Contractor shall verify dimensions in the field and shall advise the Contracting Officer of any discrepancy before performing the work.

1.3.6 Compliance

The fire detection and alarm system ~~and the central reporting system~~ shall be configured in accordance with NFPA 72; exceptions are acceptable as directed by the Contracting Officer. The equipment furnished shall be compatible and be UL listed, FM approved, or approved or listed by a nationally recognized testing laboratory in accordance with the applicable NFPA standards.

1.3.7 Qualifications

1.3.7.1 Engineer and Technician

a. Registered Professional Engineer with verification of experience and at least 4 years of current experience in the design of the fire protection and detection systems.

b. National Institute for Certification in Engineering Technologies (NICET) qualifications as an engineering technician in fire alarm systems program with verification of experience and current NICET certificate.

c. The Registered Professional Engineer may perform all required items under this specification. The NICET Fire Alarm Technician shall perform only the items allowed by the specific category of certification held.

1.3.7.2 Installer

The installing Contractor shall provide the following: ~~{NICET Fire Alarm Technicians to perform the installation of the system. A NICET Level {3} {4} Fire Alarm Technician shall supervise the installation of the fire alarm system. NICET Level 2 or higher Fire Alarm Technician may~~shall ~~install and terminate fire alarm devices, cabinets and panels. An electrician or NICET Level 1 Fire Alarm Technician shall only install conduit for the fire alarm system.}~~ ~~{Fire Alarm Technicians to perform the installation of the system. A Fire Alarm Technician with a minimum of 4 years of experience shall perform/supervise the installation of the fire alarm system. Fire Alarm Technicians with a minimum of 2 years of experience shall be utilized to assist in the installation and terminate fire alarm devices, cabinets and panels. An electrician shall be allowed to install wire or cable and to install conduit for the fire alarm system.}~~ The Fire Alarm technicians installing the equipment shall be factory trained in the installation, adjustment, testing, and operation of the equipment specified herein and on the drawings.

~~1.3.7.3 Design Services~~

~~Installations requiring designs or modifications of fire detection, fire alarm, or fire suppression systems shall require the services and review of a qualified fire protection engineer. For the purposes of meeting this requirement, a qualified fire protection engineer is defined as an individual meeting one of the following conditions:~~

- ~~a. An engineer having a Bachelor of Science or Masters of Science Degree in Fire Protection Engineering from an accredited university engineering program, plus a minimum of 2 years' work experience in fire protection engineering.~~
- ~~b. A registered professional engineer (P.E.) in fire protection engineering.~~
- ~~c. A registered PE in a related engineering discipline and member grade status in the National Society of Fire Protection Engineers.~~
- ~~d. An engineer with a minimum of 10 years' experience in fire protection engineering and member grade status in the National Society of Fire Protection Engineers.~~

1.4 SYSTEM DESIGN

1.4.1 Operation

The fire alarm and detection system shall be a complete in itself, fully supervised, addressable system complying with ADA requirements. ~~fire alarm reporting system~~ Fire Alarm System comprises of main panel located in Mech Room, a remote control panel (not too big, about 10"x10") located in Com Center and other accessories (pull stations and notification appliances etc.) distributed over the building. The system shall be activated into the alarm mode by actuation of any alarm initiating device. The system shall remain in the alarm mode until the initiating device is reset and the fire alarm control panel is reset and restored to normal. Alarm initiating devices shall be connected ~~to initiating device circuits (IDC), {Style B} {or} {Style D}, to signal line circuits (SLC), Style {5} {6}, in accordance with NFPA 72. Alarm notification appliances shall be connected to notification appliance circuits (NAC), Style Z in accordance with NFPA 72. A looped conduit system shall be provided so that if the conduit and all conductors within are severed at any point, all IDC, NAC and SLC will remain functional.~~ ~~The conduit loop requirement is not applicable to the signal transmission link from the local panels (at the protected premises) to the Supervising Station (fire station, fire alarm central communication center).~~ Textual, audible, and visual appliances and systems shall comply with NFPA 72. Fire alarm system components requiring power, except for the control panel power supply, shall operate on 24 Volts dc. Addressable system shall be microcomputer or ~~{microprocessor or microcontroller}~~ based with a minimum word size of eight bits and shall provide the following features:

- a. Sufficient memory to perform as specified and as shown for addressable system.
- b. Individual identity of each addressable device for the following conditions: alarm; trouble; open; short; and appliances missing/failed remote detector - sensitivity adjustment from the panel for smoke detectors
- c. Capability of each addressable device being individually disabled or enabled from the panel.
- d. Each SLC shall be sized to provide 40 percent addressable expansion without hardware modifications to the panel.

1.4.2 Operational Features

The system shall have the following operating features:

- a. Monitor electrical supervision of ~~{IDC,} {SLC,} and {NAC}.~~ {Smoke detectors ~~{shall} {shall not}~~ have combined alarm initiating and power circuits.}
- b. Monitor electrical supervision of the primary power (ac) supply, battery voltage, placement of alarm zone module (card, PC board) within the control panel, and transmitter tripping circuit integrity.
- c. A trouble buzzer and trouble LED/LCD (light emitting diode/liquid crystal diode) to activate upon a single break, open, or ground fault condition which prevents the required normal operation of the system. The trouble signal shall also operate upon loss of primary power (ac) supply, low battery voltage, removal of alarm zone module (card, PC board), and disconnection of the circuit used for transmitting alarm signals off-premises. A trouble alarm silence switch shall be provided which will silence the trouble buzzer, but will not extinguish the trouble indicator LED/LCD. Subsequent trouble and supervisory alarms shall sound the trouble signal until silenced. After the system returns to normal operating conditions, the trouble buzzer shall again sound until the silencing switch returns to normal position, unless automatic trouble reset is provided.
- d. A one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, ~~without activating the transmitter during the entire process.~~
- ~~e. A transmitter disconnect switch to allow testing and maintenance of the system without activating the transmitter but providing a trouble signal when disconnected and a restoration signal when reconnected.~~
- f. Evacuation alarm silencing switch which, when activated, will silence alarm devices, but will not affect the zone indicating LED/LCD, ~~nor the operation of the transmitter.~~ This switch shall be over-ridden upon activation of a subsequent alarm from an unalarmed device and the NAC devices will be activated.

- g. Electrical supervision ~~offer~~ circuits used for ~~supervisory~~ signal services and ~~(i.e., sprinkler systems, valves, etc.)~~. Supervision shall detect any open, short, or ground.
- h. Confirmation or verification of all smoke detectors operations. The control panel shall interrupt the transmission of any other alarm signal to the system control panel for a factory preset period. This interruption period shall be adjustable from 1 to 60 seconds and be factory set at ~~{20}~~ {10} seconds. Immediately following the interruption period, a confirmation period shall be in effect during which time an alarm signal, if present, will be sent immediately to the control panel. Fire alarm devices other than smoke detectors shall be programmed without confirmation or verification.
- i. The fire alarm control panel shall provide supervised addressable relays for HVAC shutdown. An override at the HVAC panel shall not be provided.
- ~~j. Provide one person test mode. Activating an initiating device in this mode will activate an alarm for a short period of time, then automatically reset the alarm, without activating the transmitter during the entire process.~~
- ~~k. The fire alarm control panel shall provide the required monitoring and supervised control outputs needed to accomplish elevator recall.~~
- ~~l. The fire alarm control panel shall monitor [and control] the fire sprinkler system, or other fire protection extinguishing system.~~
- m. The main control panel and remote control panel ~~and field panels~~ shall be software reprogrammable to enable expansion or modification of the system configuration without replacement of hardware, ~~or firmware.~~ Examples of required changes are: adding or deleting devices or zones; changing system responses to particular input signals; programming certain input signals to activate auxiliary devices.
- n. Zones for ~~{IDC}~~ ~~{and}~~ ~~{NAC}~~ shall be ~~{arranged as indicated on the contract drawings}~~ ~~{as follows:}~~ ~~{_____}~~.

1.4.3 Alarm Functions

An alarm condition on a circuit shall automatically initiate the following functions:

- ~~a. Transmission of [a signal] [signals] over the station [telephonic] [telegraphic] [radio] fire reporting system. [The signal shall be common for any device] [The signals shall be as follows: {_____}]~~.
- b. Visual indications of the alarmed devices on the main fire alarm control panel display and remote fire alarm control panel display. ~~[and on the remote audible/visual display]~~.
- c. Continuous sounding ~~or operation~~ of alarm notification appliances e.g. strobe\horn combinations and likewise devices throughout the building as required by ANSI S3.41 except Com center and bathrooms where low dBA strobe\chime combinations will be used. [only in designated areas] [throughout the building] as required by ANSI S3.41.
- ~~d. Closure of doors held open by electromagnetic devices.~~
- e. Operation of the smoke control system.
- f. Deactivation of the air handling units ~~{serving the alarmed area}~~ ~~{throughout the building}~~.
- ~~g. Shutdown of power to the data processing equipment in the alarmed area.~~
- h. Automatic discharge of the designated fire suppression systems shall be required as described and\or shown under Fire Protection System Drawings. ~~A {_____} [15] second maximum delay shall be provided for the deluge system, a {_____} [30] second delay for the wet pipe system.~~

1.4.4 Primary Power

Operating power shall be provided as required by paragraph Power Supply for the System. Transfer from normal to emergency power (battery back-up) or restoration from emergency to normal power shall be fully automatic and not cause transmission of a false alarm. Loss of ac power shall not prevent transmission of a signal via the fire reporting system upon operation of any initiating circuit.

1.4.5 Battery Backup Power

Battery backup power shall be through use of rechargeable, sealed-type storage batteries and battery charger.

~~1.4.6 Interface With Existing Fire Alarm Equipment~~

~~The equipment specified herein shall operate as an extension to an existing configuration. The new equipment shall be connected to [an existing control panel in the existing part of the building] [existing monitoring equipment at the Supervising Station (Building {_____})]. Existing [control] [monitoring] equipment shall be expanded, modified, or supplemented as necessary to extend the existing [control] [monitoring] functions to the new points or zones. New components shall be capable of merging with the existing configuration without degrading the performance of either system. The scope of the acceptance tests of paragraph Testing shall include aspects of operation that involve combined use of both new and existing portions of the final configuration.~~

1.4.6 Interface With other Equipment

Interfacing components shall be furnished as required to connect to subsystems or devices which interact with the fire alarm system, such as supervisory or alarm contacts in suppression systems, operating interfaces for smoke control systems, and addressable modules, ~~door releases~~, etc.

1.5 TECHNICAL DATA AND COMPUTER SOFTWARE

Technical data and computer software (meaning technical data which relates to computer software) which is specifically identified in this project, and is which may be defined/required for successful operation of fire alarm system in other specifications, shall be delivered, strictly in accordance with the CONTRACT CLAUSES, and in accordance with the Contract Data Requirements List, DD Form 1423. Data delivered shall be identified by reference to the particular specification paragraph against which it is furnished. Data to be submitted shall include complete system, equipment, and software descriptions. Descriptions shall show how the equipment will operate as a system to meet the performance requirements of this contract. The data package shall also include the following:

- (1) Identification of programmable portions of system equipment and capabilities.
- (2) Description of system detailing software revision requirements, ~~and expansion capabilities and methods of implementation on the detailing both equipment, and software requirements.~~
- (3) Provision of operational software data on all modes of programmable portions of the fire alarm and detection system.

- (4) Description of relationship and sequential operation of Each Fire Alarm Control Panel components.
~~equipment operation.~~
- (5) Description of auxiliary and remote equipment operations.
- (6) Library of application software.
- (7) Operation and maintenance manuals as specified in SD-19 of the Submittals paragraph.

1.6 DELIVERY AND STORAGE

Equipment delivered and placed in storage shall be stored with protection from the weather, humidity and temperature variation, dirt, dust, and any other contaminants.

PART 2 PRODUCTS

2.1 CONTROL PANELS BOTH MAIN AND REMOTE

Control Panels shall comply with the applicable requirements of UL 864. Panels shall be modular, installed in a ~~{flush-}~~ ~~{surface-}~~ or ~~{semi-flush-}~~ mounted steel cabinet with hinged door and cylinder lock. Control panels shall be a clean, uncluttered, and orderly assembled panel containing components and equipment required to provide the specified operating and supervisory functions of the system. The panels shall have prominent rigid plastic, phenolic or metal identification plates for LED/LCDs, zones, SLC, controls, meters, fuses, and switches. Nameplates for fuses shall also include ampere rating. The LED/LCD displays shall be located on the exterior of the cabinet door or be visible through the cabinet door. Control panel switches shall be within the locked cabinet. A suitable means (single operation) shall be provided for testing the control panel visual indicating devices (meters or LEDs/LCDs). Meters and LEDs shall be plainly visible when the cabinet door is closed. Signals and LEDs/LCDs shall be provided to indicate by zone any alarm, supervisory or trouble condition on the system. ~~{Each IDC shall be powered and supervised so that a signal on one zone does not prevent the receipt of signals from other devices.}~~ Loss of power, including batteries, shall not require the manual reloading of a program. Upon restoration of power, startup shall be automatic, and shall not require any manual operation. The loss of primary power or the sequence of applying primary or emergency power shall not affect the transmission of alarm, supervisory or trouble signals. Visual annunciation shall be provided for LED/LCD visual display as an integral part of the control panels and shall identify with a word description and id number each device. Cabinets shall be provided with ample gutter space to allow proper clearance between the cabinet and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate units. Cabinets shall be painted ~~{red-}~~ ~~{beige-}~~.

2.1.1 Remote Control Panel (Small Version) ~~System Audible/Visual Display~~

Audible appliance shall be low dBA buzzer for indicating trouble. Audible device for the fire alarm shall be Low dBA chime which may be either located on the remote panel or remote graphic annunciator. No duplication of audible devices for the same purpose shall be allowed. ~~have a minimum sound level output rating of [85]-~~ ~~{ } dBA at 3.05 m and shall operate in conjunction with the panel integral display.~~ ~~The audible device shall be silenced by a system silence switch on the remote system.~~ The audible device shall be silenced by the ~~system~~ ~~silencer~~ switch located at the remote panel or graphic annunciator ~~location~~, but shall not extinguish the visual indication. The remote LED/LCD visual display shall provide identification, consisting of the word description and id number for each device as displayed on the main control panel located in the Mech Room. A rigid plastic, phenolic or metal identification sign which reads "Fire Alarm System Remote Panel ~~Display~~" shall be provided at this panel. ~~e remote audible/visual display.~~ The visual indication ~~remote visual appliance~~ ~~located with the audible appliance~~ shall not be extinguished until the trouble or alarm has been cleared.

2.1.2 Circuit Connections

Circuit conductors entering or leaving the panel shall be connected to screw-type terminals with each conductor and terminal marked for identification.

2.1.3 System Expansion and Modification Capabilities

Any equipment and software needed **by qualified technicians** to implement future changes to the fire alarm system shall be provided as part of this contract.

2.1.3.1 ADDRESSABLE MODULES

Addressable modules listed in following two paragraphs are meant to clarify our addressable system requirements in general. Contractor shall make diligent effort in providing simple (not complex) but working addressable Fire Alarm System.

2.1.4 Addressable Control Module

The control module shall be capable of operating as a relay (dry contact form C) for interfacing ~~of the control panel with other systems inclding appliances, and to control door holders, or initiate elevator fire service.~~ The module shall be UL listed as compatible with the control panel. The indicating device or the external load being controlled shall be configured as a Style Y notification appliance circuits. The system shall be capable of supervising ~~all~~ audible, visual and dry contact circuits. The control module shall have both an input and output address. The supervision shall detect a short on the supervised circuit and shall prevent power from being applied to the circuit. The control module ~~ee~~ shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. The control module shall contain an integral LED that flashes each time the control module is polled. ~~{Existing fire alarm system notification appliance circuits shall be connected to a single module to power and supervise the circuit.}~~

2.1.5 Addressable Initiating Device Circuits Module

The initiating device being monitored shall be configured as a ~~{Style D-}~~ ~~{Style D-}~~ initiating device circuits. The system shall be capable of defining any module as an alarm module and report alarm trouble, loss of polling, or as a supervisory module ~~to, and reporting~~ supervisory short, supervisory open or loss of polling. The module shall be UL listed as compatible with the control panel. The monitor module shall provide address setting means compatible with the control panel's SLC supervision and store an internal identifying code. Monitor module shall contain an integral LED that flashes each time the monitor module is polled. Pull stations with a monitor module in a common backbox are not required to have an LED. ~~{Existing fire alarm system initiating device circuits shall be connected to a single module to power and supervise the circuit.}~~

2.2 STORAGE BATTERIES

Storage batteries shall be provided and shall be 24 Vdc sealed, lead-calcium type requiring no additional water. The batteries shall have ample capacity, with primary power disconnected, to operate the fire alarm system for a period of 72 hours. Following this period of battery operation, the batteries shall have ample capacity to operate all components of the system, including all alarm signaling devices in the total alarm mode for a minimum period of 15 minutes. Batteries shall be located ~~{at the bottom of the panel or}~~ ~~{in a separate battery cabinet}~~. Batteries shall be provided with overcurrent protection in accordance with NFPA 72. Separate battery cabinets shall have a lockable, hinged cover similar to the fire alarm panel. The lock shall be keyed

the same as the fire alarm control panel. Cabinets shall be painted to match the fire alarm control panel.

2.3 BATTERY CHARGER

Battery charger shall be completely automatic, 24 Vdc with high/low charging rate, capable of restoring the batteries from full discharge (18 Volts dc) to full charge within 48 hours. Charger shall have a switch and a pilot light indicating when batteries are manually placed on a high rate charging when switch is manually placed on High Charge Rate of charge shall be provided as part of the unit charger assembly, if a high rate switch is provided. Charger shall be located in control panel cabinet or in a separate battery cabinet along with batteries.

2.4 ADDRESSABLE MANUAL FIRE ALARM STATIONS

Addressable manual fire alarm stations shall conform to the applicable requirements of UL 38. Manual stations shall be connected into signal line circuits. Stations shall be installed on ~~{surface}~~ ~~{semi-flush}~~ [flush] mounted outlet boxes. Manual stations shall be mounted at ~~{1220}~~ ~~{1370}~~ ~~{_____}~~ mm. Stations shall be ~~{single}~~ ~~{double}~~ action type. Stations shall be finished in red, with raised letter operating instructions of contrasting color. Stations requiring the breaking of glass or plastic panels for operation **are not acceptable.** Stations employing glass rods ~~{are}~~ **{are not} acceptable.** The use of a key or wrench shall be required to reset the station. Gravity or mercury switches **are not acceptable.** Switches and contacts shall be rated for the voltage and current upon which they operate. Addressable pull stations shall be capable of being field programmed, shall latch upon operation and remain latched until manually reset. Stations shall have a separate screw terminal for each conductor. Surface mounted boxes shall be matched and painted the same color as the ~~{fire alarm manual stations}~~ ~~{mounting surface}~~.

2.5 FIRE DETECTING DEVICES

Fire detecting devices shall comply with the applicable requirements of NFPA 72, NFPA 90A, UL 268, UL 268A, and UL 521. The detectors shall be provided as indicated. Detector base shall have screw terminals for making connections. No solder connections will be allowed. Detectors shall be located to provide best coverage without nuisance alarm, near located in concealed locations (above ceiling and, raised floors, etc.) shall have a remote visible indicator LED/LCD. Addressable fire detecting devices, except flame detectors, shall be dynamically supervised and uniquely identified in the control panel. All fire alarm initiating devices shall be individually addressable, except where indicated. ~~Installed devices shall conform to NFPA 70 hazard classification of the area where devices are to be installed.~~

2.5.1 Heat Detectors

Heat detectors shall be designed for detection of fire by ~~{fixed temperature}~~ ~~{combination fixed temperature and rate-of-rise principle.}~~ ~~{rate compensating principle.}~~ Heat detector spacing shall be rated in accordance with UL 521. Detectors located in areas subject to moisture, ~~exterior atmospheric conditions, or hazardous locations [as defined by NFPA 70]~~ ~~{and} [as shown on drawings]~~, shall be types approved for such locations. Heat detectors located in attic spaces or similar concealed spaces below the roof shall be intermediate temperature rated.

2.5.1.1 Combination Fixed-Temperature and Rate-of-Rise Detectors

Detectors shall be designed for ~~{surface or}~~ ~~{semi-flush}~~ outlet box mounting and supported independently of wiring connections. Contacts shall be self-resetting after response to rate-of-rise principle. Under fixed temperature actuation, the detector shall have a permanent external indication which is readily visible. ~~Detector units located in boiler rooms, showers, or other areas subject to abnormal temperature changes shall operate on fixed temperature principle only.~~ The UL 521 test rating for the fixed temperature portion shall be ~~{57.2}~~ ~~{_____}~~ degrees C. ~~{as shown.}~~ The UL 521 test rating for the Rate-of-Rise detectors shall be rated for 15 by 15 m.

2.5.1.2 ~~Rate Compensating Detectors~~

~~Detectors shall be {surface} {flush} mounted {vertical} {horizontal} type, with outlet box supported independently of wiring connections. Detectors shall be hermetically sealed and automatically resetting. Rate-Compensated detectors shall be rated for 15 by 15 m.~~

2.5.1.3 ~~Fixed Temperature Detectors~~

~~Detectors shall be designed for {surface} {semi-flush} outlet box mounting and supported independently of wiring connections. Detectors shall be designed to detect high heat. The detectors shall have a specific temperature setting of {57.2} {_____} degrees C. {as shown.} The UL 521 test rating for the fixed-temperature detectors shall be rated for 4.57 by 4.57 m.~~

2.5.2 Smoke Detectors

Smoke detectors shall be designed for detection of abnormal smoke densities. Smoke detectors shall be ~~{ionization or}~~ ~~{photoelectric}~~ ~~{or}~~ ~~{projected beam}~~ type. Detectors shall contain a visible indicator LED/LCD that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Detectors shall be the plug-in type in which the detector base contains terminals for making wiring connections. Detectors that are to be installed in concealed (above false ceilings, etc.) locations shall be provided with a remote indicator LED/LCD suitable for mounting in a finished, visible location.

2.5.2.1 Ionization Detectors

Ionization detectors with a dual chamber shall be responsive to both invisible and visible particles of combustion. One chamber shall be a reference chamber and the second a sampling chamber. Detectors containing radium shall not be provided. Detectors shall not cause an alarm condition due to anticipated fluctuations in relative humidity. The sensitivity of the detector shall be field adjustable to compensate for operating conditions. Detector shall require no replacement or readjustment to restore it to normal operation after an alarm condition. Each detector shall be capable of withstanding ambient air velocity up to ~~{1.5}~~ ~~{_____}~~ meters per second in accordance with UL 268. Addressable smoke detectors shall be capable of having the sensitivity being remotely adjusted by the control panel.

2.5.2.2 Photoelectric Detectors

Detectors shall operate on a light scattering concept using an LED light source. Failure of the LED shall not cause an alarm condition. Detectors shall be factory set for sensitivity and shall require no field adjustments of any kind. Detectors shall have an obscuration rating in accordance with UL 268. Addressable smoke detectors shall be capable of having the sensitivity being remotely adjusted by the control panel.

2.5.2.3 Projected Beam Smoke Detectors

Detectors shall be designed for detection of abnormal smoke densities. Detectors shall consist of separate transmitter and receiver units. The transmitter unit shall emit an infrared beam to the receiver unit. When the signal at the receiver falls below a preset sensitivity, the detector shall initiate an alarm. The receiver shall contain an LED which is powered upon an alarm condition. Long-term changes to the received signal caused by environmental variations shall be automatically compensated. Detectors shall incorporate features to assure that they are operational; a trouble signal shall be initiated if the beam is obstructed, the limits of the compensation circuit are reached, or the housing cover is removed. Detectors shall have

multiple sensitivity settings in order to meet UL listings for the different distances covered by the beam. In the event of beam interference for more than three seconds a trouble alarm shall be transmitted.

2.5.2.4 Duct Detectors

Duct-mounted photoelectric smoke detectors shall be furnished and installed where indicated and in accordance with NFPA 90A. Units shall consist of a smoke detector as specified in paragraph Photoelectric Detectors, mounted in a special housing fitted with duct sampling tubes. Detector circuitry shall be mounted in a metallic enclosure exterior to the duct. Detectors shall have a manual reset. Detectors shall be rated for air velocities that include air flows between {2.5 and 20} { } and { } m/s. Detectors shall be powered from the fire alarm panel. Sampling tubes shall run the full width of the duct. The duct detector package shall conform to the requirements of NFPA 90A, UL 268A, and shall be UL listed for use in air-handling systems. The control functions, operation, reset, and bypass shall be controlled from the fire alarm control panel. Lights to indicate the operation and alarm condition; and the test and reset buttons shall be visible and accessible with the unit installed and the cover in place. Detectors mounted above 1.83 m and those mounted below 1.83 m that cannot be easily accessed while standing on the floor, shall be provided with a remote detector indicator panel containing test and reset switches. Remote lamps and switches as well as the affected fan units shall be properly identified in etched plastic placards. Detectors shall have auxiliary contacts to provide control, interlock, and shutdown functions specified in Section 15950 HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS. The detectors shall be supplied by the fire alarm system manufacturer to ensure complete system compatibility.

2.5.3 Combination Smoke and Heat Detectors

Combination smoke and heat detectors shall have an audible device (self-contained) and be designed for detection of abnormal smoke densities by the photoelectric principle and abnormal heat by a fixed temperature sensor. Smoke detectors shall be provided with an LED light source. Failure of the LED shall not cause an alarm condition and the sensitivity shall be factory set at a nominal {3} { } percent and require no field adjustments of any kind. Heat detector portion shall be fixed temperature sensor rated at 57 degrees C. The audible appliances shall have a minimum sound output of at least {85} { } dBA at 3.05 m. Detectors shall contain a visible indicator LED that shows when the unit is in alarm condition. Detectors shall not be adversely affected by vibration or pressure. Heat detectors shall connect to a control panel {SLC} {IDC} and shall be ~~{non restorable}~~ {self restorable} type only after a time delay and positive delivery of signal to control panel.

~~2.5.4 Flame Detectors~~

~~The detectors shall comply with FM P7825a. The detectors shall be sensitive to the micron range best suited for their intended use. The detectors shall operate over electrically supervised wiring circuits and the loss of power to the detector shall result in a trouble signal. A self test feature shall be provided for each detector to be individually tested.~~

~~2.5.4.1 Infrared (IR) Single Frequency Flame Detector~~

~~The detector shall be sensitive in the range of { } to { } micrometers only.~~

~~2.5.4.2 Infrared (IR) Dual Frequency Flame Detector~~

~~The IR detector shall consist of two or more IR sensors, each selected for a different IR frequency. The primary sensor shall be sensitive in the range of { } to { } micrometers only. Secondary sensors are tuned to different IR wavelengths to null out the effect of black body radiation to the primary sensor.~~

~~2.5.4.3 Ultraviolet (UV) Flame Detectors~~

~~UV flame detector shall be of the narrow band response type which operates on radiated ultraviolet energy and shall be sensitive in the range of { } to { } micrometers only. The cone of vision shall be 80 degrees or greater. Each detector shall be completely insensitive to light sources in the visible frequency range.~~

~~2.5.4.4 Combination UV/IR Flame Detector~~

~~The UV/IR detector shall provide discrimination against false alarms by requiring both UV and IR flame detection before an alarm is sent. The UV sensor shall be sensitive in the range of 0.185 to 0.265 micrometers only. The IR sensor shall be sensitive in the range of { } to { } micrometers only. Detectors shall be completely insensitive to light sources in the visible frequency range.~~

2.6 AUDIO\VISUAL NOTIFICATION APPLIANCES

Notification appliances in this project shall be 85 dBA sound-level combination Strobe\Horn combination and low dBA sound level Strobe\Bell or Strobe\Chime combination at different locations as listed below & else where, and as shown on the drawings..

Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible notification appliance employed in the fire alarm systems shall be approved by the Contracting Officer.

2.7 AUDIBLE NOTIFICATION APPLIANCES

Audible appliances shall conform to the applicable requirements of UL 464. These ~~d~~Devices shall be only connected into notification appliance circuits. Devices shall have a separate screw terminal for each conductor. Audible appliances shall generate a unique audible sound (distinct from other devices provided in the building and surrounding area for other purposes). Surface mounted audible appliances shall be painted {red} {white} { }. Recessed audible appliances shall be installed with a grill that is painted {red} {white} { } or {with a factory finish to match the surface to which it is mounted}.

2.7.1 Alarm Bells And Chimes

~~Bells and Chimes~~ shall be surface mounted or ceiling mounted with the matching mounting back box {surface mounted as shown} {recessed}. Bells and chimes ~~shall be the underdome type producing a minimum a Low Level dBA output appropriate for the specific location. output rating of {85} { } dBA at 3.1 m. Bells used in exterior locations shall be specifically listed or approved for outdoor use and be provided with metal housing and protective grilles. Single stroke, electrically operated, supervised, solenoid bells shall be used for coded applications.~~

2.7.2 Alarm Horns

Horns shall be surface mounted, with the matching mounting back box {surface mounted} {recessed} with {single or} {double} projector, {grille and} vibrating type suitable for use in an electrically supervised circuit. Horns shall produce a sound rating of at least {85} { } dBA at 3.05 m (10 feet). Horns used in exterior locations shall be specifically listed or approved for outdoor use (90 dBA at 10 feet) and be provided with metal housing and protective grilles.

~~2.6.3 Chimes~~

~~Chimes shall be electrically operated, supervised, electronic type, with an adjustable frequency of 800 to 1200~~

~~Hertz. Chimes shall have a minimum sound rating of [80] [] dBA at 3.05 m. [Chimes shall ring the bell codes, as indicated.]~~

2.7.3 Visual Notification Appliances

Visual notification appliances shall conform to the applicable requirements of UL 1971 and the contract drawings. Appliances shall have clear high intensity optic lens, xenon flash tubes, and output white light. Strobe flash rate shall be between 1 to 3 flashes per second and a minimum of 175 candela. Strobe shall be ~~+~~ surface~~+~~ or ~~+~~ semi-flush~~+~~ mounted.

~~2.6.5 Combination Audible/Visual Notification Appliances~~

~~Combination audible/visual notification appliances shall provide the same requirements as individual units except they shall mount as a unit in standard backboxes. Units shall be factory assembled. Any other audible notification appliance employed in the fire alarm systems shall be approved by the Contracting Officer.~~

2.7.4 Voice Evacuation System

The voice evacuation system shall provide for ~~one-way~~ ~~two-way~~ voice communications, routing and pre-amplification of digital alarm tones and voice (digital and analog) messages. The system shall be zoned for messages (Custom and prerecorded) and tones as indicated on the drawings. The following electronic tones shall be available from the amplifier: Slow Whoop, High/Low, Horn, Chime, Beep, Stutter, Wail and Bell. The system shall have a microphone, integrated with intercom system (Refer Spec 16721A) to ~~and~~ allow for general paging within the space. Operation shall be either manually from a control switch located in Com Center. ~~or automatically from the fire alarm control panel.~~ Reset shall be accomplished by the fire alarm control panel during panel reset.

2.8 FIRE DETECTION AND ALARM SYSTEM PERIPHERAL EQUIPMENT

~~2.7.1 Electromagnetic Door Hold Open Devices~~

~~Devices shall be attached to the walls unless otherwise indicated. Devices shall comply with the appropriate requirements of UL 228. Devices shall operate on 24 Volt dc power. Compatible magnetic component shall be attached to the door. Under normal conditions, the magnets shall attract and hold the doors open. When magnets are de-energized, they shall release the doors. Magnets shall have a holding force of 111.2 N (25 pounds). Devices shall be UL or FM approved. Housing for devices shall be brushed aluminum or stainless steel. Operation shall be fail safe with no moving parts. Electromagnetic door hold open devices shall not be required to be held open during building power failure.~~

2.8.1 Conduit

Conduit and fittings shall comply with NFPA 70, UL 6, UL 1242, and UL 797.

2.8.2 Wiring

Wiring shall conform to NFPA 70. Wiring for 120 Vac power shall be No. 12 AWG minimum. The SLC wiring shall be ~~fiber optic~~ ~~for~~ ~~copper~~ cable in accordance with the manufacturers requirements. Wiring for fire alarm dc circuits shall be No. ~~16~~ ~~14~~ AWG minimum. Voltages shall not be mixed in any junction box, housing, or device, except those containing power supplies and control relays. Wiring shall conform to NFPA 70. System field wiring shall be solid copper and installed in metallic conduit or electrical metallic tubing, except that rigid plastic conduit may be used under slab-on-grade. Conductors shall be color coded. Conductors used for the same functions shall be similarly color coded. Wiring code color shall remain uniform throughout the circuit. Pigtail or T-tap connections to initiating device circuits, supervisory alarm circuits, and notification appliance circuits are prohibited. T-tapping using screw terminal blocks is allowed for style 5 addressable systems.

2.8.3 Special Tools and Spare Parts

Software, connecting cables and proprietary equipment, necessary for the maintenance, testing, and reprogramming of the equipment shall be furnished to the Contracting Officer. Two spare fuses of each type and size required shall be furnished. Two percent of the total number of each different type of detector, but no less than two each, shall be furnished. Spare fuses shall be mounted in the fire alarm panel.

~~2.8 TRANSMITTERS~~

~~2.8.1 Radio Alarm Transmitters~~

~~Transmitters shall be compatible with proprietary supervising station receiving equipment. Each radio alarm transmitter shall be the manufacturer's recognized commercial product, completely assembled, wired, factory tested, and delivered ready for installation and operation. Transmitters shall be provided in accordance with applicable portions of NFPA 72, NFPA 1221, and 47 CFR 15. Transmitter electronics module shall be contained within the physical housing as an integral, removable assembly. The proprietary supervising station receiving equipment is [] and the transceiver shall be fully compatible with this equipment. At the contractors option, and if UL listed, the transmitter may be housed in the same panel as the fire alarm control panel.~~

~~2.8.1.1 Transmitter Power Supply~~

~~Each radio alarm transmitter shall be powered by a combination of locally available 120 volt ac power and a sealed, lead calcium battery.~~

~~a. Operation: Each transmitter shall operate from 120-volt ac power. In the event of 120-volt ac power loss, the transmitter shall automatically switch to battery operation. Switchover shall be accomplished with no interruption of protective service, and shall automatically transmit a trouble message. Upon restoration of ac power, transfer back to normal ac power supply shall also be automatic. Each transmitter shall meet the following requirements: [].~~

~~b. Battery Power: Transmitter standby battery capacity shall provide sufficient power to operate the transmitter in a normal standby status for a minimum of 72 hours and be capable of transmitting alarms during that period.~~

~~2.8.1.2 Radio Alarm Transmitter Housing~~

~~Transmitter housing shall be NEMA Type 1. The housing shall contain a lock that is keyed [identical to the fire alarm system for the building.] [identical to radio alarm transmitter housings on the base.] Radio alarm transmitter housing shall be factory painted with a suitable priming coat and not less than two coats of a hard, durable weatherproof enamel.~~

~~2.8.1.3 Antenna~~

~~The Contractor shall provide [omnidirectional, coaxial, halfwave dipole antennas] [] for radio alarm transmitters with a driving point impedance to match transmitter output. The antenna and antenna mounts shall be corrosion resistant and designed to withstand wind velocities of 161 km/h. Antennas shall not be mounted to any portion of the building roofing system.~~

~~2.8.2 Master Fire Alarm Boxes~~

~~Master fire alarm boxes shall be of the coded, [shunt] [positive] noninterfering type with succession features having a [shunt] [local energy] type auxiliary tripping device, and of the prewound, open door, pull lever type. Mechanism shall be housed in a weatherproof cottage shell type of housing with metallic or rigid plastic code number plate mounted on the exterior face of the cottage shell. Operation of the actuating pull lever shall cause the box to transmit four complete rounds of code to gongs, recorders, and other devices on the same circuit. Driving springs shall have the capability to transmit not less than eight complete four round groups of code before being rewound. Boxes shall be designed for operation of 100 milliamperes dc, but with capability of full operation of 70 milliamperes and up to 120 milliamperes. Activation of box when a single open fault is present on exterior fire alarm circuit shall have box to idle for one complete round only, then immediately transmit four complete code rounds via the box earth ground connection. Each box shall be equipped with manual signaling key, telephone jack, silent test device, and box shunt device. Box shall be [[wall]-[pole]-[pedestal]-] mounted] [as indicated] with center of box 1525 mm above grade, and provided with lighting fixture. Mounting bolts, brackets, fastenings, and conduit shall be copper alloy, cadmium, or zinc-coated steel. Code wheel shall be metallic and box code shall be as directed. Electrically powered master fire alarm boxes shall have standby sealed, lead calcium battery capacity for a minimum of 72 hours and be capable of transmitting alarms during that period.~~

2.8.3 Telephonic Reporting System

~~Transmitters shall be compatible with existing receiving equipment at the Supervising Station and shall comply with applicable requirements of UL 632. Transmitter shall respond to the actuation of the fire alarm control panel and shall be of the electric motor-driven or prewound spring mechanism type; it shall transmit not less than four rounds of code. When motor driven transmitters are provided, the motor shall be connected to a supervised circuit in a control panel. Metallic or rigid plastic code number plates on the exterior face of transmitters shall be provided. Transmitters shall be designed to provide the same features as the fire alarm boxes for electrically supervised, coded [positive] [shunt] noninterfering type and shall have the ability to transmit signals on grounded or open circuits. Activation of box when a single open fault is present on exterior fire alarm circuit shall have box to idle for one complete round only, then immediately transmit four complete code rounds via the box earth ground connection. Transmitter shall have a [shunt] [local energy] type auxiliary tripping device. Code wheel shall be metallic and box code shall be as directed. Wiring shall be extended to the indicated telephone terminating location [for future connection by other] [and connected to specific twisted pair cable identified by the COR in the field]. [One new [] pair [shielded]-[non shielded] twisted pair cable shall be extended to the Supervising Station and connected to existing terminating equipment.]~~

PART 3 EXECUTION

3.1 INSTALLATION

All work shall be installed as shown and in accordance with the manufacturer's diagrams and recommendations, unless otherwise specified. Smoke detectors shall not be installed until construction is essentially complete and the building has been thoroughly cleaned.

3.1.1 Power Supply for the System

A single dedicated circuit connection for supplying power from a branch circuit to ~~each~~ building fire alarm system shall be provided. The power shall be supplied as shown on the drawings. The power supply shall be equipped with a locking mechanism and marked in red with the words "FIRE ALARM CIRCUIT CONTROL".

3.1.2 Wiring

Conduit size for wiring shall be in accordance with NFPA 70.- Wiring for the fire alarm system shall not be installed in conduits, junction boxes, or outlet boxes with conductors of lighting and power systems. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal. Circuit conductors entering or leaving any mounting box, outlet box enclosure, or cabinet shall be connected to screw terminals with each terminal and conductor marked in accordance with the wiring diagram. Connections and splices shall be made using screw terminal blocks. The use of wire nut type connectors in the system is prohibited. Wiring within any control equipment shall be readily accessible without removing any component parts. The fire alarm equipment manufacturer's representative shall be present for the connection of wiring to the control panel.

3.1.3 Control Panels

The control panels and its assorted components shall be mounted so that no part of the enclosing cabinet is less than 300 mm nor more than 2000 mm above the finished floor. Manually operable controls shall be between ~~900 and 1100 mm~~ to 1525mm above the finished floor unless noted otherwise. Panel shall be installed to comply with the requirements of UL 864.

3.1.4 Detectors

Detectors shall be located and installed in accordance with NFPA 72. Detectors shall be connected into signal line circuits or initiating device circuits as per NFPA indicated on the drawings. Detectors shall be at least 300 mm from any part of any lighting fixture. Detectors shall be located at least 900 mm from diffusers of air handling systems. Each detector shall be provided with appropriate mounting hardware as required by its mounting location. Detectors which mount in open space shall be mounted directly to the end of the stubbed down rigid conduit drop. Conduit drops shall be firmly secured to minimize detector sway. Where length of conduit drop from ceiling or wall surface exceeds 900 mm, sway bracing shall be provided. Detectors installed in concealed locations (above ceiling, ~~raised floors, etc.~~) shall have a remote visible indicator LED/LCD ~~{in a finished, visible location.} [as indicated] []~~.

3.1.5 Notification Appliances

Notification appliances shall be mounted ~~2438003 mm~~ above the finished floor or 150 mm below the ceiling, whichever is lower.

3.1.6 Annunciator Equipment

Annunciator ~~equipment~~ shall be located in Com Center ~~mounted where~~as indicated on the drawings.

3.1.7 Addressable Initiating Device Circuits Module

The initiating device circuits module shall be used to connect supervised conventional initiating devices (water flow switches, water pressure switches, manual fire alarm stations, high/low air pressure switches, and tamper switches). The module shall mount in an electrical box adjacent to or connected to the device it is monitoring and shall be capable of Style B supervised wiring to the initiating device. In order to maintain proper supervision, there shall be no T-taps allowed on style B lines. Addressable initiating device circuits modules shall monitor only one initiating device each. Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform supervisory and alarm functions as specified in [Section {13930 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION}] ~~{13935 DRY PIPE SPRINKLER SYSTEM, FIRE PROTECTION}~~ ~~{13945 PREACTION AND DELUGE SPRINKLER SYSTEMS, FIRE PROTECTION}~~ ~~{ } [NFPA 72]~~, as indicated on the drawings and as specified herein.

3.1.8 Addressable Control Module

Addressable and control modules shall be installed in the outlet box or adjacent to the device they are controlling. ~~If a supplementary suppression releasing panel is provided, then the monitor modules shall be mounted in a common enclosure adjacent to the suppression releasing panel and both this enclosure and the suppression releasing panel shall be in the same room as the releasing devices.~~ All interconnecting wires shall be supervised unless an open circuit or short circuit abnormal condition does not affect the required operation of the fire alarm system. If control modules are used as interfaces to other systems, such as HVAC ~~or elevator control~~, ~~these~~y shall be within the control panel or immediately adjacent to it. Control modules that control a group of notification appliances shall be adjacent to the first notification appliance in the notification appliance circuits. All control modules installation shall comply with NFPA. Control modules that connect to devices shall supervise the notification appliance circuits. ~~Control modules that connect to auxiliary systems or interface with other systems (non life safety systems) and where not required by NFPA 72, shall not require the secondary circuits to be supervised.~~ Contacts in suppression systems and other fire protection subsystems shall be connected to the fire alarm system to perform required alarm functions as specified in [Section {13930 WET PIPE SPRINKLER SYSTEM, FIRE PROTECTION}] {13935 DRY PIPE SPRINKLER SYSTEM, FIRE PROTECTION}] {13945 PREACTION AND DELUGE SPRINKLER SYSTEMS, FIRE PROTECTION}] {_____} {NFPA 72}, as indicated on the drawings and as specified herein.

3.2 OVERVOLTAGE AND SURGE PROTECTION

3.2.1 Power Line Surge Protection

All equipment connected to alternating current circuits shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. Fuses shall not be used for surge protection. The surge protector shall be rated for a maximum let thru voltage of 350 Volts ac (line-to-neutral) and 350 Volt ac (neutral-to-ground).

3.2.2 Low Voltage DC Circuits Surge Protection

All ~~[IDC]~~ [IDC, and NAC, and communication cables/conductors], ~~except fiber optics~~, shall have surge protection installed at each point where it exits or enters a building. Equipment shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. The surge protector shall be rated to protect the 24 Volt dc equipment. The maximum dc clamping voltages shall be 36 V (line-to-ground) and 72 Volt dc (line-to-line).

3.2.3 Signal Line Circuit Surge Protection

All SLC cables/conductors, ~~except fiber optics~~, shall have surge protection/isolation circuits installed at each point where it exits or enters a building. The circuit shall be protected from surges per IEEE C62.41 B3 combination waveform and NFPA 70. The surge protector/isolator shall be rated to protect the equipment.

3.3 GROUNDING

Grounding shall be provided by connecting to building ground system.

~~3.4 SUPERVISING STATION PROVISIONS~~

~~{The proprietary type Supervising Station (PSS) is located [in building [____]] [____]} {The supervising equipment is existing and consists of the following brands and models: [supervising station control panel [____]] [____], [signal reporting components [____]], [annunciator [____]] [____]}.~~

~~3.4.1 Revisions to Existing Facilities~~

~~Existing supervising components shall be modified as indicated on the drawings and programming shall be updated if required to accommodate the revised configuration. Acceptance testing shall include procedures that would demonstrate that operation of existing equipment has not been degraded and that the revised configuration plus interfacing components operates compatibly with the new fire alarm system at the protected premises. Work on existing equipment shall be performed in accordance with the manufacturer's instructions or under supervision of the manufacturer's representative.~~

~~3.4.2 Additions to Existing Facilities~~

~~Supplemental components shall be added to the existing supervising equipment [as required to accommodate the new fire alarm system to be installed at the protected premises] [as indicated on the drawings]. All present functions shall be extended, including recording and storage in memory, and programming shall be updated if required to accommodate the revised configuration. Acceptance testing shall include procedures that would demonstrate that operation of existing equipment has not been degraded and that the expanded configuration operates compatibly with the new fire alarm system.~~

3.4 TESTING

The Contractor shall notify the Contracting Officer at least 10 days before the preliminary and acceptance tests are to be conducted. The tests shall be performed in accordance with the approved test procedures in the presence of the Contracting Officer. The control panel manufacturer's representative shall be present to supervise tests. The Contractor shall furnish instruments and personnel required for the tests.

3.4.1 Preliminary Tests

Upon completion of the installation, the system shall be subjected to functional and operational performance tests including tests of each installed initiating and notification appliance, when required. Tests shall include the meggering of system conductors to determine that the system is free from grounded, shorted, or open circuits. The megger test shall be conducted prior to the installation of fire alarm equipment. If deficiencies are found, corrections shall be made and the system shall be retested to assure that it is functional. After completing the preliminary testing the Contractor shall complete and submit the NFPA 72, Certificate of Completion.

3.4.2 Acceptance Test

Acceptance testing shall not be performed until the Contractor has completed and submitted the Certificate of Completion. Testing shall be in accordance with NFPA 72. The recommended tests in NFPA 72 shall be considered mandatory and shall verify that previous deficiencies have been corrected. The Contractor shall complete and submit the NFPA 72, Inspection and Testing Form. The test shall include all requirements of NFPA 72 and the following:

- a. Test of each function at Each~~of the~~ control panel.
- b. Test of each circuit in both trouble and normal modes.
- c. Tests of each alarm initiating devices in both normal and trouble conditions.
- d. Tests of each control circuit and device.
- e. Tests of each alarm notification appliance.
- f. Tests of the battery charger and batteries.
- g. Complete operational tests under emergency power supply.

- h. Visual inspection of wiring connections.
- i. Opening the circuit at each alarm initiating device and notification appliance to test the wiring supervisory feature.
- j. Ground fault
- k. Short circuit faults
- l. Stray voltage
- m. Loop resistance

3.5 TRAINING

Training course shall be provided for the operations and maintenance staff. The course shall be conducted in the building where the system is installed and/or as designated and defined by the Contracting Officer. The training period for systems operation shall consist of 2 to 3~~+1~~~~+~~~~_____~~ training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The training period for systems maintenance shall consist of ~~+2~~~~+~~~~_____~~ training days (8 hours per day) and shall start after the system is functionally completed but prior to final acceptance tests. The instructions shall cover items contained in the operating and maintenance instructions. In addition, training shall be provided on performance of expansions or modifications to the fire detection and alarm system. The training period for system expansions and modifications shall consist of at least ~~+1~~~~+~~~~_____~~ training days (8 hours ~~max per day~~) and shall start after the system is functionally completed but prior to final acceptance tests.

-- End of Section --

SECTION TABLE OF CONTENTS

DIVISION 16 - ELECTRICAL

SECTION 16375A

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 GENERAL REQUIREMENTS
 - 1.2.1 Terminology
 - 1.2.2 Service Conditions
- 1.3 SUBMITTALS
- 1.4 DELIVERY, STORAGE, AND HANDLING
- 1.5 EXTRA MATERIALS

PART 2 PRODUCTS

- 2.1 STANDARD PRODUCT
- 2.2 NAMEPLATES
 - 2.2.1 General
 - 2.2.2 Liquid-Filled Transformer Nameplates
- 2.3 CORROSION PROTECTION
 - 2.3.1 Aluminum Materials
 - 2.3.2 Ferrous Metal Materials
 - 2.3.2.1 Hardware
 - 2.3.2.2 Equipment
 - 2.3.3 Finishing
- 2.4 CABLES
 - 2.4.1 Medium-Voltage Cables
 - 2.4.1.1 General
 - 2.4.1.2 Ratings
 - 2.4.1.3 Conductor Material
 - 2.4.1.4 Insulation
 - 2.4.1.5 Shielding
 - 2.4.1.6 Neutrals
 - 2.4.1.7 Jackets
 - 2.4.2 Low-Voltage Cables
 - 2.4.2.1 Conductor Material
 - 2.4.2.2 Insulation
 - 2.4.2.3 Jackets
 - 2.4.2.4 In Duct
- 2.5 CABLE TERMINATIONS, AND CONNECTORS
 - 2.5.1 Medium-Voltage Cable Terminations
 - 2.5.2 Medium-Voltage Separable Insulated Connectors
 - 2.5.3 Terminations
 - 2.5.3.1 Factory Preformed Type
 - 2.5.3.2 Taped Terminations
- 2.6 CONDUIT AND DUCTS
 - 2.6.1 Metallic Conduit
 - 2.6.2 Nonmetallic Ducts
 - 2.6.2.1 Concrete Encased Ducts
 - 2.6.3 Conduit Sealing Compound
- 2.7 HANDHOLES AND PULLBOXES
- 2.8 TRANSFORMERS
 - 2.8.1 Pad-Mounted Transformers
 - 2.8.1.1 High-Voltage Compartments
 - 2.8.1.2 Load-Break Switch
 - 2.8.1.3 Transformer Tank Sections
 - 2.8.1.4 Low-Voltage Cable Compartments
 - 2.8.1.5 Accessories
- 2.9 METERING AND PROTECTIVE DEVICES
 - 2.9.1 Circuit Breakers, Low-Voltage
 - 2.9.1.1 Low-Voltage Power Circuit Breakers
 - 2.9.1.2 Molded-Case Circuit Breakers
 - 2.9.2 Fuses, Medium-Voltage, Including Current-Limiting
 - 2.9.2.1 Construction
 - 2.9.2.2 Ratings
 - 2.9.2.3 E-Rated, Current-Limiting Power Fuses
 - 2.9.2.4 C-Rated, Current-Limiting Power Fuses
 - 2.9.3 Fuses, Low-Voltage, Including Current-Limiting
 - 2.9.3.1 Cartridge Fuses
 - 2.9.3.2 Transformer Circuit Fuses
 - 2.9.4 Instrument Transformers
 - 2.9.4.1 General
 - 2.9.4.2 Current Transformers
 - 2.9.4.3 Current Transformers for Kwh and Demand Metering (Low-Voltage)
 - 2.9.5 Watthour Meters
- 2.10 SURGE ARRESTERS
- 2.11 GROUNDING AND BONDING
 - 2.11.1 Driven Ground Rods
 - 2.11.2 Grounding Conductors
- 2.12 CONCRETE AND REINFORCEMENT
- 2.13 PADLOCKS
- 2.14 CABLE FIREPROOFING SYSTEMS
 - 2.14.1 Fireproof Coating
 - 2.14.2 Fireproofing Tape
 - 2.14.3 Plastic Tape
- 2.15 LIQUID DIELECTRICS
- 2.16 FACTORY TESTS

PART 3 EXECUTION

- 3.1 GENERAL INSTALLATION REQUIREMENTS
 - 3.1.1 Conformance to Codes
 - 3.1.2 Verification of Dimensions
 - 3.1.3 Disposal of Liquid Dielectrics
- 3.2 CABLE INSTALLATION

- 3.2.1 Cable Installation Plan and Procedure
 - 3.2.1.1 Cable Inspection
 - 3.2.1.2 Duct Cleaning
 - 3.2.1.3 Duct Lubrication
 - 3.2.1.4 Cable Installation
 - 3.2.1.5 Cable Installation Plan
- 3.2.2 Duct Line
- 3.2.3 Insect and Rodent Damage
- 3.2.4 Electric Handholes
- 3.3 FIREPROOFING
 - 3.3.1 Tape Method
 - 3.3.2 Sprayable Method
- 3.4 DUCT LINES
 - 3.4.1 Requirements
 - 3.4.2 Treatment
 - 3.4.3 Concrete Encasement
 - 3.4.4 Installation of Couplings
 - 3.4.4.1 Plastic Duct
 - 3.4.5 Duct Line Markers
- 3.5 HANDHOLES, AND PULLBOXES
 - 3.5.1 General
 - 3.5.2 Electric Handholes
 - 3.5.3 Communications Handholes
 - 3.5.4 Pullboxes
 - 3.5.5 Ground Rods
- 3.6 PAD-MOUNTED EQUIPMENT INSTALLATION
 - 3.6.1 Concrete Pads
 - 3.6.1.1 Construction
 - 3.6.1.2 Concrete and Reinforcement
 - 3.6.1.3 Sealing
 - 3.6.2 Padlocks
- 3.7 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS
- 3.8 GROUNDING
 - 3.8.1 Grounding Electrodes
 - 3.8.2 Grounding and Bonding Connections
 - 3.8.3 Grounding and Bonding Conductors
 - 3.8.4 Surge Arrester Grounding
 - 3.8.5 Handhole, or Concrete Pullbox Grounding
 - 3.8.6 Metal Splice Case Grounding
 - 3.8.7 Riser Pole Grounding
- 3.9 FIELD TESTING
 - 3.9.1 General
 - 3.9.2 Safety
 - 3.9.3 Ground-Resistance Tests
 - 3.9.4 Medium-Voltage Cable Test
 - 3.9.5 Low-Voltage Cable Test
 - 3.9.6 Liquid-Filled Transformer Tests
 - 3.9.7 Dry-Type Transformer Tests
 - 3.9.8 Circuit Breaker Tests
 - 3.9.9 Power Circuit Breaker Tests
 - 3.9.10 Operating Tests
- 3.10 ACCEPTANCE

-- End of Section Table of Contents --

SECTION 16375A
ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C12.4 (1984; R 1996) Mechanical Demand Registers

ANSI C12.10 (1997) Electromechanical Watthour Meters

ANSI C12.11 (1987; R 1993) Instrument Transformers for Revenue Metering, 10 kV BIL through 350 kV BIL (0.6 kV NSV through 69 kV NSV)

ANSI C29.1 (1988; R 1996) Electrical Power Insulators - Test Methods

ANSI C37.16 (2000) Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations

ANSI C37.46 (1981; R 1992) Power Fuses and Fuse Disconnecting Switches

ANSI C37.50 (1989; R 1995) Switchgear, Low-Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures

ANSI C37.72 (1987) Manually-Operated Dead-Front, Padmounted Switchgear with Load-Interrupting Switches and Separable Connectors for Alternating-Current Systems

ANSI C37.121 (1989; R 1995) Switchgear, Unit Substations Requirements

ANSI C57.12.13 (1982) Conformance Requirements for Liquid-Filled Transformers Used in Unit Installations, Including Unit Substations

ANSI C57.12.21 (1995) Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with High-Voltage Bushings; (High-Voltage, 34 500 Grd Y/19 920 Volts and Below; Low-Voltage, 240/120; 167 kVA and Smaller)

ANSI C57.12.26 (1993) Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High-Voltage, 34 500 Grd Y/19 920 Volts and Below; 2500 kVa and Smaller

ANSI C57.12.27 (1982) Conformance Requirements for Liquid-Filled Distribution Transformers Used in Pad-Mounted Installations, Including Unit Substations

ANSI C57.12.28 (1999) Switchgear and Transformers - Padmounted Equipment - Enclosure Integrity

ANSI C80.1 (1995) Rigid Steel Conduit - Zinc Coated

ANSI C119.1 (1986; R 1997) Sealed Insulated Underground Connector Systems Rated 600 Volts

ANSI C135.30 (1988) Zinc-Coated Ferrous Ground Rods for Overhead or Underground Line Construction

ANSI O5.1 (1992) Specifications and Dimensions for Wood Poles

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM A 48 (1994ael) Gray Iron Castings

ASTM A 48M (1994ael) Gray Iron Castings (Metric)

ASTM A 123/A 123M (2000) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153/A 153M (2000) Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM B 3 (1995) Soft or Annealed Copper Wire

ASTM B 8 (1999) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus

ASTM B 231/B 231M (1999) Concentric-Lay-Stranded Aluminum 1350 Conductors

ASTM B 400 (1994) Compact Round Concentric-Lay-Stranded Aluminum 1350 Conductors

ASTM B 496 (1999) Compact Round Concentric-Lay-Stranded Copper Conductors

ASTM B 609/B 609M (1999) Standard Specification for Aluminum 1350 Round Wire, Annealed and Intermediate Tempers, for Electrical Purposes

ASTM B 800 (2000) 8000 Series Aluminum Alloy Wire for Electrical Purposes-Annealed and Intermediate Tempers

ASTM B 801 (1999) Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy for Subsequent Covering or Insulation

ASTM C 478 (1997) Precast Reinforced Concrete Manhole Sections

ASTM C 478M (1997) Precast Reinforced Concrete Mahhole Sections (Metric)

ASTM D 923 (1997) Sampling Electrical Insulating Liquids

ASTM D 1654 (1992) Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments

ASTM D 2472 (2000) Sulfur Hexafluoride

ASTM D 4059 (1996) Analysis of Polychlorinated Biphenyls in Insulating Liquids by Gas Chromatography

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS5 (1994; CS5a-1995) Cross-linked Polyethylene Insulated Shielded Power Cables Rated 5 Through 46 kV

AEIC CS6 (1996) Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 Through 69 kV

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a (1998) Approval Guide Fire Protection

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (1997) National Electrical Safety Code

IEEE C37.1 (1994) IEEE Standard Definition, Specification, and Analysis of Systems Used for Supervisory Control, Data Acquisition, and Automatic Control

IEEE C37.2 (1996) Electrical Power System Device Function Numbers and Contact Designations

IEEE C37.13 (1990; R 1995) Low-Voltage AC Power Circuit Breakers Used in Enclosures

IEEE C37.20.1 (1993) Metal-Enclosed Low-Voltage Power Circuit-Breaker Switchgear

IEEE C37.20.2 (1993; C37.20.2b) Metal-Clad and Station-Type Cubicle Switchgear

IEEE C37.20.3 (1997) Metal-Enclosed Interrupter Switchgear

IEEE C37.23 (1987; R 1991) Guide for Metal-Enclosed Bus and Calculating Losses in Isolated-Phase Bus

IEEE C37.30 (1997) Requirements for High-Voltage Switches

IEEE C37.34 (1994) Test Code for High-Voltage Air Switches

IEEE C37.41 (1994; C37.41c) Design Tests for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories

IEEE C37.63 (1997) Requirements for Overhead, Pad-Mounted, Dry-Vault, and Submersible Automatic Line Sectionalizer for AC Systems

IEEE C37.90 (1989; R 1994) Relays and Relay Systems Associated with Electric Power Apparatus

IEEE C37.90.1 (1989; R 1994) IEEE Standard Surge Withstand Capability (SWC) Tests for Protective Relays and Relay Systems

IEEE C37.98 (1987; R 1991) Seismic Testing of Relays

IEEE C57.12.00 (1993) IEEE Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers

IEEE C57.13 (1993) Instrument Transformers

IEEE C57.98 (1993) Guide for Transformer Impulse Tests

IEEE C62.1 (1989; R 1994) Surge Arresters for AC Power Circuits

IEEE C62.2 (1987; R 1994) Guide for the Application of Gapped Silicon-Carbide Surge Arresters for Alternating Current Systems

IEEE C62.11 (1999) IEEE Standard Metal-Oxide Surge Arresters for AC Power Circuits

IEEE Std 48 (1998) Standard Test Procedures and Requirements for Alternating-Current Cable Terminations 2.5 kV through 765 kV

IEEE Std 81 (1983) Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System (Part 1)

IEEE Std 100 (1997) IEEE Standard Dictionary of Electrical and Electronics Terms

IEEE Std 242 (1986; R 1991) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems

IEEE Std 386 (1995) Separable Insulated Connector Systems for Power Distribution Systems Above 600V

IEEE Std 399 (1997) Recommended Practice for Industrial and Commercial Power Systems Analysis

IEEE Std 404 (1993) Cable Joints for Use with Extruded Dielectric Cable Rated 5000 V through 138 000 V and Cable Joints for Use with Laminated Dielectric Cable Rated 2500 V Through 500 000 V

IEEE Std 592 (1990; R 1996) Exposed Semiconducting Shields on Premolded High Voltage Cable Joints and Separable Insulated Connectors

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA AB 1 (1993) Molded Case Circuit Breakers and Molded Case Switches

NEMA BU 1 (1994) Busways

NEMA FB 1 (1993) Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies

NEMA FU 1 (1986) Low Voltage Cartridge Fuses

NEMA LA 1	(1992) Surge Arresters
NEMA PB 1	(1990) Panelboards
NEMA PB 2	(1995) Deadfront Distribution Switchboards
NEMA SG 2	(1993) High Voltage Fuses
NEMA SG 3	(1995) Power Switching Equipment
NEMA SG 5	(1995) Power Switchgear Assemblies
NEMA TC 5	(1990) Corrugated Polyolefin Coilable Plastic Utilities Duct
NEMA TC 6	(1990) PVC and ABS Plastic Utilities Duct for Underground Installation
NEMA TC 7	(1990) Smooth-Wall Coilable Polyethylene Electrical Plastic Duct
NEMA WC 7	(1988; Rev 3 1996) Cross-Linked-Thermosetting-Polyethylene- Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NEMA WC 8	(1988; Rev 3; 1996) Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)	
NFPA 70	(1999) National Electrical Code
UNDERWRITERS LABORATORIES (UL)	
UL 6	(1997) Rigid Metal Conduit
UL 198C	(1986; Rev thru Feb 1998) High-Interrupting-Capacity Fuses, Current-Limiting Types
UL 198D	(1995) Class K Fuses
UL 198E	(1988; Rev Jul 1988) Class R Fuses
UL 198H	(1988; Rev thru Nov 1993) Class T Fuses
UL 467	(1993; Rev thru Apr 1999) Grounding and Bonding Equipment
UL 486A	(1997; Rev thru Dec 1998) Wire Connectors and Soldering Lugs for Use with Copper Conductors
UL 486B	(1997; Rev Jun 1997) Wire Connectors for Use with Aluminum Conductors
UL 489	(1996; Rev thru Dec 1998) Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures
UL 510	(1994; Rev thru Apr 1998) Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape
UL 514A	(1996; Rev Dec 1999) Metallic Outlet Boxes
UL 651	(1995; Rev thru Oct 1998) Schedule 40 and 80 Rigid PVC Conduit
UL 854	(1996; Rev Oct 1999) Service-Entrance Cables
UL 857	(1994; Rev thru Dec 1999) Busways and Associated Fittings
UL 1072	(1995; Rev Mar 1998) Medium Voltage Power Cable
UL 1242	(1996; Rev Mar 1998) Intermediate Metal Conduit
UL 1684	(2000) Reinforced Thermosetting Resin Conduit (RTRC) and Fittings

1.2 GENERAL REQUIREMENTS

1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

1.2.2 Service Conditions

Items provided under this section shall be specifically suitable for the following service conditions. Seismic details shall [conform to Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT] [be as indicated].

- a. Altitude 450 feet (137.2 m)
- b. Ambient Temperature 0 to 120 degrees F
- c. Frequency 60 Hertz
- d. Seismic Parameters 4

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Electrical Distribution System; FIO

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

Detail drawings shall as a minimum depict the installation of the following items:

- a. Medium-voltage cables and accessories including cable installation plan.
- b. Transformers.
- c. Fuel tank mounted generator.
- d. Switchboard.
- e. Surge arresters.

As-Built Drawings; FIO

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

SD-03 Product Data

Nameplates; FIO

Catalog cuts, brochures, circulars, specifications, product data, and printed information in sufficient detail and scope to verify compliance with the requirements of the contract documents.

Material and Equipment; FIO

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

General Installation Requirements; FIO

As a minimum, installation procedures for transformers, generators, switchboards, and medium-voltage cable terminations and splices.

Procedures shall include cable pulling plans, diagrams, instructions, and precautions required to install, adjust, calibrate, and test the devices and equipment.

SD-06 Test Reports

Factory Tests; FIO

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

Field Testing; GA

A proposed field test plan, 30 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field test procedures including tests to be performed, test equipment required, and tolerance limits.

Operating Tests; FIO

Three copies of the information described below in 215.9 by 279.4 mm (8-1/2 by 11 inch) binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.

- d. The equipment and values to be verified.
- e. The condition specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

Cable Installation; FIO

Three copies of the information described below in 215.9 by 279.4 mm (8-1/2 by 11 inch) binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

- a. Site layout drawing with cable pulls numerically identified.
- b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.
- c. The cable manufacturer and type of cable.
- d. The dates of cable pulls, time of day, and ambient temperature.
- e. The length of cable pull and calculated cable pulling tensions.
- f. The actual cable pulling tensions encountered during pull.

SD-07 Certificates

Material and Equipment; FIO

Where materials or equipment are specified to conform to the standards of the Underwriters Laboratories (UL) or to be constructed or tested, or both, in accordance with the standards of the American National Standards Institute (ANSI), the Institute of Electrical and Electronics Engineers (IEEE), or the National Electrical Manufacturers Association (NEMA), the Contractor shall submit proof that the items provided conform to such requirements. The label of, or listing by, UL will be acceptable as evidence that the items conform. Either a certification or a published catalog specification data statement, to the effect that the item is in accordance with the referenced ANSI or IEEE standard, will be acceptable as evidence that the item conforms. A similar certification or published catalog specification data statement to the effect that the item is in accordance with the referenced NEMA standard, by a company listed as a member company of NEMA, will be acceptable as evidence that the item conforms. In lieu of such certification or published data, the Contractor may submit a certificate from a recognized testing agency equipped and competent to perform such services, stating that the items have been tested and that they conform to the requirements listed, including methods of testing of the specified agencies. Compliance with above-named requirements does not relieve the Contractor from compliance with any other requirements of the specifications.

Cable Installer Qualifications; GA

The Contractor shall provide at least one onsite person in a supervisory position with a documentable level of competency and experience to supervise all cable pulling operations. A resume shall be provided showing the cable installers' experience in the last three years, including a list of references complete with points of contact, addresses and telephone numbers.

SD-10 Operation and Maintenance Data

Electrical Distribution System; FIO

Six copies of operation and maintenance manuals, within 7 calendar days following the completion of tests and including assembly, installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers and switches shall be stored in accordance with the manufacturer's requirements. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

PART 2 PRODUCTS

2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

2.2 NAMEPLATES

2.2.1 General

Each major component of this specification shall have the manufacturer's name, address, type or style, model or serial number, and catalog number on a nameplate securely attached to the equipment. Nameplates shall be made of noncorrosive metal. Equipment containing liquid dielectrics shall have the type of dielectric on the nameplate. As a minimum, nameplates shall be provided for transformers, generator, meters, switches, and switchboard.

2.2.2 Liquid-Filled Transformer Nameplates

Power transformers shall be provided with nameplate information in accordance with IEEE C57.12.00. Nameplates shall indicate the number of liters and composition of liquid-dielectric, and shall be permanently marked with a statement that the transformer dielectric to be supplied is non-polychlorinated biphenyl. If transformer nameplate is not so marked, the Contractor shall furnish manufacturer's certification for each transformer that the dielectric is non-PCB classified, with less than 2 ppm PCB content in accordance with paragraph LIQUID DIELECTRICS. Certifications shall be related to serial numbers on transformer nameplates. Transformer dielectric exceeding the 2 ppm PCB content or transformers without certification will be considered as PCB insulated and will not be accepted.

2.3 CORROSION PROTECTION

2.3.1 Aluminum Materials

Aluminum shall not be used.

2.3.2 Ferrous Metal Materials

2.3.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

2.3.2.2 Equipment

Equipment and component items, including but not limited to transformer stations and ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 120 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1.6 mm (1/16 inch) from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

2.3.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTING, GENERAL.

2.4 CABLES

Cables shall be single conductor type unless otherwise indicated.

2.4.1 Medium-Voltage Cables

2.4.1.1 General

Cable construction shall be Type MV, conforming to NFPA 70 and UL 1072. Cables shall be manufactured for use in duct applications as indicated.

2.4.1.2 Ratings

Cables shall be rated for a circuit voltage of 15 kV as indicated.

2.4.1.3 Conductor Material

Underground cables shall be soft drawn copper complying with ASTM B 3 and ASTM B 8 for regular concentric and compressed stranding or ASTM B 496 for compact stranding.

2.4.1.4 Insulation

Cable insulation shall be cross-linked thermosetting polyethylene (XLP) insulation conforming to the requirements of NEMA WC 7 and AEIC CS5 or ethylene-propylene-rubber (EPR) insulation conforming to the requirements of NEMA WC 8 and AEIC CS6. A 133 percent insulation level shall be used on 15 kV rated cables. Recyclable materials (insulation) shall conform to EPA requirements.

2.4.1.5 Shielding

Cables rated for 2 kV and above shall have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape shield for each phase. The shield tape shall be sized to meet IEEE C2 requirements for a ground fault availability of 10,000 amp or more.

2.4.1.6 Neutrals

[Neutral conductors shall be copper, employing the same insulation and jacket materials as phase conductors, except that a 600-volt insulation rating is acceptable.]

2.4.1.7 Jackets

Cables shall be provided with a PVC or polyethylene jacket.

2.4.2 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70, and must be UL listed for the application or meet the applicable section of either ICEA or NEMA standards.

2.4.2.1 Conductor Material

Underground cables shall be annealed copper complying with ASTM B 3 and ASTM B 8 or Type AA-8000 aluminum conductors complying with ASTM B 800 and ASTM B 801. Intermixing of copper and aluminum conductors is not permitted.

2.4.2.2 Insulation

Insulation must be in accordance with NFPA 70, and must be UL listed for the application or meet the applicable sections of either ICEA, or NEMA standards.

2.4.2.3 Jackets

Multiconductor cables shall have an overall PVC outer jacket.

2.4.2.4 In Duct

Cables shall be single-conductor cable, in accordance with NFPA 70. Cables in factory-installed, coilaible-plastic-duct assemblies shall conform to NEMA TC 5 or NEMA TC 7.

2.5 CABLE TERMINATIONS, AND CONNECTORS

2.5.1 Medium-Voltage Cable Terminations

Medium-voltage cable terminations shall comply with IEEE Std 48.

2.5.2 Medium-Voltage Separable Insulated Connectors

Separable insulated connectors shall comply with IEEE Std 386 and IEEE Std 592 and shall be of suitable construction or standard splice kits shall be used. Separable insulated connectors are acceptable for voltages up to 35 kV. Connectors shall be of the loadbreak type as indicated, of suitable construction for the application and the type of cable connected, and shall include cable shield adaptors. Separable insulated connectors shall not be used as substitutes for conventional permanent splices. External clamping points and test points shall be provided.

2.5.3 Terminations

Terminations shall be in accordance with IEEE Std 48, Class 1 ~~or Class 2;~~ of the molded elastomer, wet-process porcelain, prestretched elastomer, heat-shrinkable elastomer, or taped type. Acceptable elastomers are track-resistant silicone rubber or track-resistant ethylene propylene compounds, such as ethylene propylene rubber or ethylene propylene diene monomer. Separable insulated connectors may be used for apparatus terminations, when such apparatus is provided with suitable bushings. Terminations shall be of the outdoor type, ~~except that where installed inside outdoor equipment housings which are sealed against normal infiltration of moisture and outside air, indoor, Class 2 terminations are acceptable.~~ Class 3 terminations are not acceptable. Terminations, where required, shall be provided with mounting brackets suitable for the intended installation and with grounding provisions for the cable shielding, metallic sheath, and armor.

2.5.3.1 Factory Preformed Type

Molded elastomer, wet-process porcelain, prestretched, and heat-shrinkable terminations shall utilize factory preformed components to the maximum extent practicable rather than tape build-up. Terminations shall have basic impulse levels as required for the system voltage level. Leakage distances shall comply with wet withstand voltage test requirements of IEEE Std 48 for the next higher Basic Insulation Level (BIL) level. † Anti-tracking tape shall be applied over exposed insulation of preformed molded elastomer terminations‡.

2.5.3.2 Taped Terminations

Taped terminations shall use standard termination kits providing terminal connectors, field-fabricated stress cones, and rain hoods. Terminations shall be at least 510 mm long from the end of the tapered cable jacket to the start of the terminal connector, or not less than the kit manufacturer's recommendations, whichever is greater.

2.6 CONDUIT AND DUCTS

Ducts shall be single, round-bore type, with wall thickness and fittings suitable for the application. Duct lines shall be concrete-encased, thin-wall type. Low-voltage lines or Communication line runs shall also be in thin-wall type concrete encased ducts. Where concrete encasement is not required, low-voltage circuits may utilize factory-installed cable in coilaible plastic duct.

2.6.1 Metallic Conduit

Intermediate metal conduit shall comply with UL 1242. Rigid galvanized steel conduit shall comply with UL 6 and ANSI C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

2.6.2 Nonmetallic Ducts

2.6.2.1 Concrete Encased Ducts

UL 651 Schedule 40 or NEMA TC 6 Type EB.

2.6.3 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 2 degrees C (35 degrees F), shall neither slump at a temperature of 150 degrees C (300 degrees F), nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

2.7 HANDHOLES AND PULLBOXES

Handholes, and pullboxes shall be as indicated. Strength of handholes, and pullboxes and their frames and covers shall conform to the requirements of IEEE C2. Precast-concrete handholes shall have the required strength established by ASTM C 478, ASTM C 478M. Frames and covers shall be made of gray cast iron and a machine-finished seat shall be provided to ensure a matching joint between frame and cover. Cast iron shall comply with ASTM A 48M, Class 30B, minimum. Handholes for low voltage cables installed in parking lots, sidewalks, and turfed areas shall be fabricated from an aggregate consisting of sand and with continuous woven glass strands having an overall compressive strength of at least 10,000 psi and a flexural strength of at least 5000 psi. Pullbox and handhole covers in sidewalks, and turfed areas shall be of the same material as the box. Concrete pullboxes shall consist of precast reinforced concrete boxes, extensions, bases, and covers.

2.8 TRANSFORMERS

Transformers shall be of the outdoor type having the ratings and arrangements indicated. Medium-voltage ratings of cable terminations shall be 15 kV between phases for 133 percent insulation level.

2.8.1 Pad-Mounted Transformers

Pad-mounted transformers shall comply with ANSI C57.12.26 and shall be of the radial feed type. Pad-mounted transformer stations shall be assembled and coordinated by one manufacturer and each transformer station shall be shipped as a complete unit so that field installation requirements are limited to mounting each unit on a concrete pad and connecting it to primary and secondary lines. Stainless steel pins and hinges shall be provided. Barriers shall be provided between high- and low-voltage compartments. High-voltage compartment doors shall be interlocked with low-voltage compartment doors to prevent access to any high-voltage section

unless its associated low-voltage section door has first been opened. Compartments shall be sized to meet the specific dimensional requirements of ANSI C57.12.26. Pentahead locking bolts shall be provided with provisions for a padlock.

2.8.1.1 High-Voltage Compartments

The high-voltage compartment shall be dead-front construction. Primary switching and protective devices shall include loadbreak switching, oil-immersed, bayonet-type, overload fuse in series with a partial range current-limiting fuse, medium-voltage separable loadbreak connectors, universal bushing wells and inserts or integral one piece bushings and surge arresters. Fuses shall comply with the requirements of paragraph METERING AND PROTECTIVE DEVICES. The switch shall be mounted inside transformer tank with switch operating handle located in high-voltage compartment and equipped with metal loop for hook stick operation. Fuses shall be interlocked with switches so that fuses can be removed only when the associated switch is in the "OPEN" position. Adjacent to medium-voltage cable connections, a nameplate or equivalent stencilled inscription shall be provided inscribed "DO NOT OPEN CABLE CONNECTORS UNLESS SWITCH IS OPEN." Surge arresters shall be fully insulated and configured to terminate on the same bushing as the primary cable by means of a loadbreak, feed-through bushing insert ~~or a second set of high voltage bushings~~.

2.8.1.2 Load-Break Switch

Radial-feed oil-immersed type rated at 15 kV, 95 kV BIL, with a continuous current rating and load-break rating of 200 ampere, and a make-and-latch rating of 10,000 rms amperes symmetrical. Locate the switch handle in the high-voltage compartment.

2.8.1.3 Transformer Tank Sections

Transformers shall comply with IEEE C57.12.00, ANSI C57.12.21, and ANSI C57.12.26 and shall be of the mineral oil-insulated type or less-flammable, liquid-insulated type with ~~high molecular-weight hydrocarbon~~ or dimethyl silicone liquid. Transformers shall be suitable for outdoor use and shall have 2 separate windings per phase. Standard NEMA primary taps shall be provided. Where primary taps are not specified, 4, 2-1/2 percent rated kVA high-voltage taps shall be provided ~~2 above and 2 below~~ ~~below~~ rated, primary voltage. Operating handles for primary tap changers for de-energized operation shall be located within high-voltage compartments, externally to transformer tanks. Adjacent to the tap changer operating handle, a nameplate or equivalent stenciled inscription shall be provided and inscribed "DO NOT OPERATE UNDER LOAD." Transformer ratings at 60 Hz shall be as follows:

Three-phase capacity.....500 kVA.
Impedance.....4.5 %[____].
Temperature Rise.....65 degrees C.
High-voltage winding.....13.8 Kilo volts.
High-voltage winding connections.....Delta.
Low-voltage winding.....480y277 volts.
Low-voltage winding connections..... grounded wye

2.8.1.4 Low-Voltage Cable Compartments

Neutrals shall be provided with fully-insulated bushings. Clamp type cable terminations, suitable for copper conductors entering from below, shall be provided as necessary.

2.8.1.5 Accessories

High-voltage warning signs shall be permanently attached to each side of transformer stations. Voltage warning signs shall comply with IEEE C2. Copper-faced steel or stainless steel ground connection pads shall be provided in both the high- and low-voltage compartments. Dial-type thermometer, liquid-level gauge, and drain valve with built-in sampling device shall be provided for each transformer station. Insulated-bushing-type parking stands shall be provided adjacent to each separable load-break elbow to provide for cable isolation during sectionalizing operations.

2.9 METERING AND PROTECTIVE DEVICES

2.9.1 Circuit Breakers, Low-Voltage

2.9.1.1 Low-Voltage Power Circuit Breakers

a. Construction

Low-voltage power circuit breakers shall conform to IEEE C37.13, ANSI C37.16, and NEMA SG 3 and shall be three-pole, single-throw, stored energy, ~~manually~~ operated type except where shown electrically ~~electrically-operated~~, with drawout mounting. Solid-state trip elements which require no external power connections shall be provided. Circuit breakers shall have an open/close contact indicator, primary disconnect devices, and a mechanical interlock to prevent making or breaking contact of primary disconnections when the circuit breaker is closed. Control voltage shall be ~~24 48 125 V dc or 120 V ac~~ ~~as indicated~~. The circuit breaker enclosure shall be suitable for its intended location.

b. Ratings

Voltage ratings shall be not less than the applicable circuit voltage. Circuit breakers shall be rated for 100 percent continuous duty and shall have trip current ratings and frame sizes as shown. Nominal voltage ratings, maximum continuous-current ratings, and maximum short-circuit interrupting ratings shall be in accordance with ANSI C37.16. Tripping features shall be as follows:

1. Long-time current pick-up, adjustable from 50 percent to 100 percent of sensor current rating.
2. Adjustable long-time delay.
3. Short-time current pick-up, adjustable from 1.5 to 9 times long-time current setting.
4. Adjustable short-time delay.
5. [Short-time I2t switch.]
6. Instantaneous current pick-up, adjustable from 1.5 to 9 times long-time current setting.
7. Ground-fault pick-up, adjustable from 20 percent to 60 percent of sensor rating, but in no case greater than 1200 amperes. Sensing of ground-fault current at the main bonding jumper or ground strap shall not be permitted. ~~Zone selective interlocking shall be provided as shown.~~

- 8. ~~{Fixed}~~~~{Adjustable}~~ ground-fault delay.
- 9. ~~{Ground-fault I2t switch.}~~
- 10. ~~{Overload}~~~~{and}~~, ~~{short-circuit}~~ ~~{and}~~ ~~{ground-fault}~~ trip indicators shall be provided.

2.9.1.2 Molded-Case Circuit Breakers

NEMA AB 1 and UL 489.

2.9.2 Fuses, Medium-Voltage, Including Current-Limiting

2.9.2.1 Construction

Units shall be suitable for outdoor use. Fuses shall have integral blown-fuse indicators. All ratings shall be clearly visible.

2.9.2.2 Ratings

~~{Expulsion type}~~ ~~{Current-limiting}~~ power fuses shall have ratings in accordance with ANSI C37.46 and as follows:

- Nominal voltage.....13.8 KV~~{_____}~~.
- Rated maximum voltage.....13.8KV~~{_____}~~.
- Maximum symmetrical interrupting capacity.....Per Mfr's recommendations~~{_____}~~.
- Rated continuous current.....30~~{_____}~~.
- BIL.....110KV~~{_____}~~.

2.9.2.3 E-Rated, Current-Limiting Power Fuses

E-rated, current-limiting, power fuses shall conform to ANSI C37.46.

2.9.2.4 C-Rated, Current-Limiting Power Fuses

C-rated, current-limiting power fuses shall open in 1000 seconds at currents between 170 and 240 percent of the C rating.

2.9.3 Fuses, Low-Voltage, Including Current-Limiting

Low-voltage fuses shall conform to NEMA FU 1. Time delay ~~or~~ and nontime delay ~~fuses~~ options shall be as utilized where protection is needed but no protection is provided.~~{shown}~~ ~~{specified}~~. Equipment provided under this contract shall be provided with a complete set of properly rated fuses when the equipment manufacturer utilizes fuses in the manufacture of the equipment, or if current-limiting fuses are required to be installed to limit the ampere-interrupting capacity of circuit breakers or equipment to less than the maximum available fault current at the location of the equipment to be installed. Fuses shall have a voltage rating of not less than the phase-to-phase circuit voltage, and shall have the time-current characteristics required for effective power system coordination.

2.9.3.1 Cartridge Fuses

Cartridge fuses, current-limiting type, Class [G] [J] [K] [L] [RK1] [RK5] [RK9] [T] [CC] shall have tested interrupting capacity not less than [100,000] [200,000] amperes. Fuse holders shall be the type that will reject Class H fuses.

- a. Class [G] [J] [L] [CC] fuses shall conform to UL 198C.
- b. Class K fuses shall conform to UL 198D.
- c. Class R fuses shall conform to UL 198E.
- d. Class T fuses shall conform to UL 198H.

2.9.3.2 Transformer Circuit Fuses

Transformer circuit fuses shall be Class RK1 or RK5, current-limiting, time-delay with 200,000 amperes interrupting capacity.

2.9.4 Instrument Transformers

2.9.4.1 General

Instrument transformers shall comply with ANSI C12.11 and IEEE C57.13. Instrument transformers shall be configured for mounting in/on the device to which they are applied. Polarity marks on instrument transformers shall be visually evident and shown on drawings.

2.9.4.2 Current Transformers

~~Unless otherwise indicated, bar, wound, or window-type transformers are acceptable; and except for window-type units installed over insulated buses, transformers shall have a BIL rating consistent with the rated BIL of the associated switchgear or electric power apparatus bushings, buses or conductors. Current transformers shall have the indicated ratios. The continuous thermal current rating factor shall not be less than [1.0] [1.2] [1.5] [2.0] [3.0] [4.0]. Other thermal and mechanical ratings of current transformers and their primary leads shall be coordinated with the design of the circuit breaker and shall be not less than the momentary rating of the associated circuit breaker. Circuit protectors shall be provided across secondary leads of the current transformers to prevent the accident open circuiting of the transformers while energized. Each terminal of each current transformer shall be connected to a short circuiting terminal block in the circuit interrupting mechanism cabinet, power transformer terminal cabinet, and in the associated instrument and relay cabinets.~~ In this application standard metering class accuracy is needed.

~~2.10.4.3 Current Transformers for Power Transformers~~

~~{Single ratio} {Multi ratio} bushing type current transformers shall be provided internally around power-transformer bushings as shown. {Single ratio units shall have a minimum relaying accuracy class of [0.6B 0.5] [0.3B 0.5].} {Multi ratio units shall have a minimum relaying accuracy voltage class of [_____] for either a C or T classification.}~~

~~2.10.4.4 Current Transformers for Metal-Enclosed Switchgear~~

~~Single ratio units, used for metering and relaying, shall have a metering accuracy class rating of [_____]~~

~~{B. ____}. Single ratio units, used only for relaying, shall have a relaying accuracy class rating of {____} for {either} a C {or T} classification.~~

2.9.4.3 Current Transformers for Kwh and Demand Metering (Low-Voltage)

Current transformers shall conform to IEEE C57.13. Provide current transformers with a standard metering accuracy Class of 0.3 through {____}, with a minimum RF of {____} at 30 degrees C, with 600-volt insulations, and 10 kV BIL. Provide butyl-molded, window-type current transformers mounted on the transformer low-voltage bushings. Route current transformer leads to a metering location shown on drawings~~in a location as remote as possible away~~ from the power transformer secondary cables to permit current measurements to be taken with hook-on-ammeters. ~~in the current transformer cabinet.~~

2.10.4.6 Voltage Transformers

~~Voltage transformers shall have indicated ratios. Units shall have an accuracy class rating of {____}. Voltage transformers shall be of the drawout type having current-limiting fuses in both primary and secondary circuits. Mechanical interlocks shall prevent removal of fuses, unless the associated voltage transformer is in a drawout position. Voltage transformer compartments shall have hinged doors.~~

2.9.5 Watthour Meters

Watthour meters shall conform to ANSI C12.10, except numbered terminal wiring sequence and case size may be the manufacturer's standard. Watthour meters shall be of the ~~{drawout switchboard type} {socket mounted {outdoor} {indoor} type}~~ having a ~~{15} {30} {60} {____}~~ minute, cumulative form, demand register meeting ANSI C12.4 and provided with not less than 2-1/2 staters. ~~{Watthour demand meters shall have factory-installed electronic pulse initiators. Pulse initiators shall be solid-state devices incorporating light-emitting diodes, phototransistors, and power transistors, except that mercury-wetted output contacts are acceptable. Initiators shall be totally contained within watthour demand meter enclosures, shall be capable of operating up to speeds of 500 pulses per minute with no false pulses, and shall require no field adjustments. Initiators shall be calibrated for a pulse rate output of 1 pulse per 1/4 disc revolution of the associated meter and shall be compatible with the indicated equipment}.~~

2.10.6 Protective Relaying

2.10.6.1 General

~~{Solid state} {Microprocessor based} protective relays shall be provided as shown and shall be of a type specifically designed for use on power switchgear or associated electric power apparatus. Protective relays shall conform to IEEE C37.90. Relays and auxiliaries shall be suitable for operation with the instrument transformer ratios and connections provided.~~

2.10.6.2 Construction

~~Relays shall be dustproof and moisture resistant. Necessary test devices shall be incorporated within each relay and shall provide a means for testing either from an external source of electric power or from associated instrument transformers. Each relay shall be provided with an operation indicator and an external target reset device. Relays shall have necessary auxiliaries for proper operation. Relays and auxiliaries shall be suitable for operation with the instrument transformer ratios and connections provided.~~

2.10.6.3 Ratings

~~Relays shall be the manufacturer's standard items of equipment with appropriate ranges for time dial, tap, and other settings. Relay device numbers shall correspond to the function names and descriptions of IEEE C37.2.~~

2.10 SURGE ARRESTERS

Surge arresters shall comply with NEMA LA 1, IEEE C62.1, IEEE C62.2, and IEEE C62.11 and shall be provided where indicated. Arresters shall be ~~{station} {intermediate} {distribution}~~ class, rated as shown. ~~Arresters for use at elevations in excess of 1.8 km (6000 feet) above mean sea level shall be specifically rated for that purpose.~~ Arresters shall be equipped with mounting brackets suitable for the indicated installations. Arresters shall be of the ~~{valve} {or} {metal-oxide varistor} {or} {combination valve-metal-oxide varistor}~~ type.

2.11 GROUNDING AND BONDING

2.11.1 Driven Ground Rods

Ground rods shall be ~~{copper-clad steel conforming to UL 467 or} {zinc-coated steel conforming to ANSI C135.30} {solid stainless steel}~~ not less than ~~{15.9 mm (5/8 inch)} {19 mm (3/4 inch)} {2.44 m (8 feet)}~~ in diameter by ~~{3.1 m (10 feet)} {2.44 m (8 feet)}~~ in length. Sectional type rods may be used.

2.11.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

2.12 CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete reinforcing shall be as specified in Section 03200 CONCRETE REINFORCEMENT.

2.13 PADLOCKS

Padlocks shall comply with Section 08710 DOOR HARDWARE.

2.14 CABLE FIREPROOFING SYSTEMS

Cable fireproofing systems shall be listed in FM P7825a as a fire-protective coating or tape approved for grouped electrical conductors and shall be suitable for application on the type of medium-voltage cables provided. After being fully cured, materials shall be suitable for use where exposed to oil, water, gases, salt water, sewage, and fungus and shall not damage cable jackets or insulation. Asbestos materials are not acceptable.

2.14.1 Fireproof Coating

Cable fireproofing coatings shall be compounded of water-based thermoplastic resins, flame-retardant chemicals, and inorganic noncombustible fibers and shall be suitable for the application methods used. Coatings applied on bundled cables shall have a derating factor of less than 5 percent, and a dielectric strength of 95 volts per mil minimum after curing.

2.14.2 Fireproofing Tape

Fireproofing tape shall be at least 50 mm (2 inches) wide and shall be a flexible, conformable, polymeric, elastomer tape designed specifically for fireproofing cables.

2.14.3 Plastic Tape

Preapplication plastic tape shall be pressure sensitive, 0.254 mm (10 mil) thick, conforming to UL 510.

2.15 LIQUID DIELECTRICS

Liquid dielectrics for transformers, capacitors, reclosers, and other liquid-filled electrical equipment shall be non-polychlorinated biphenyl (PCB) mineral-oil or less-flammable liquid as specified. Nonflammable fluids shall not be used. Tetrachloroethylene (perchloroethylene) and 1, 2, 4 trichlorobenzene fluids shall not be used. Liquid dielectrics in retrofitted equipment shall be certified by the manufacturer as having less than ~~{50}~~~~{2}~~ parts per million (ppm) PCB content. In lieu of the manufacturer's certification, the Contractor may submit a test sample of the dielectric in accordance with ASTM D 923 and have tests performed per ASTM D 4059 at a testing facility approved by the Contracting Officer. Equipment with test results indicating PCB level exceeding ~~{50}~~~~{2}~~ ppm shall be replaced.

2.16 FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least ~~{10}~~ 30 days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

- a. Transformers: Manufacturer's standard ~~{routine,}~~ ~~{design}~~ ~~{and}~~ ~~{other}~~ tests in accordance with IEEE C57.12.00.
- b. Transformers rated 200 kVA and above: Reduced full-wave, chopped-wave, and full-wave impulse test on each line and neutral terminal, in accordance with IEEE C57.98.
- c. High-Voltage Air Switches: Manufacturer's standard tests in accordance with IEEE C37.34 and IEEE C37.41.
- d. Protective Relays: Seismic tests in accordance with IEEE C37.98. Surge withstand tests in accordance with IEEE C37.90.1.
- e. Relaying Current Transformers: Manufacturer's standard tests in accordance with IEEE C57.13.
- f. Instrument Current Transformers: Manufacturer's standard tests in accordance with IEEE C57.13.
- g. Factory Preformed Terminations: Wet withstand voltage tests in accordance with IEEE Std 48 for the next higher BIL level.
- h. Outdoor Switchgear: Manufacturer's standard tests in accordance with IEEE C37.20.1, IEEE C37.20.2, and IEEE C37.20.3.
- i. Electrical Power Insulators: Manufacturer's standard tests in accordance with ANSI C29.1.
- j. ~~{_____}~~.

~~2.18 FENCING~~

~~Fencing shall conform to the requirements of Section 02821 CHAIN LINK FENCE.~~

PART 3 EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. ~~Circuits installed aerially shall conform to the requirements of Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.~~ Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR UTILITIES SYSTEMS. Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

3.1.3 Disposal of Liquid Dielectrics

PCB-contaminated dielectrics must be marked as PCB and transported to and incinerated by an approved EPA waste disposal facility. The Contractor shall furnish certification of proper disposal. Contaminated dielectrics shall not be diluted to lower the contamination level.

3.2 CABLE INSTALLATION

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then ~~{prepare a checklist of significant requirements}~~ ~~{perform pulling calculations and prepare a pulling plan}~~ which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS.

3.2.1 Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each handhole, junction box, and each terminal. Each tag shall contain the following information: cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

3.2.1.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

3.2.1.2 Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 6.4 mm (1/4 inch) less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 131 cubic centimeters (8 cubic inches) of debris is expelled from the duct.

3.2.1.3 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

3.2.1.4 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 10 degrees C (50 degrees F) temperature for at least 24 hours before installation.

3.2.1.5 Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

- a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.
- b. List of cable installation equipment.
- c. Lubricant manufacturer's application instructions.
- d. Procedure for resealing cable ends to prevent moisture from entering cable.
- e. Cable pulling tension calculations of all cable pulls.
- f. Cable percentage conduit fill.
- g. Cable sidewall thrust pressure.
- h. Cable minimum bend radius and minimum diameter of pulling wheels used.
- i. Cable jam ratio.
- j. Maximum allowable pulling tension on each different type and size of conductor.
- k. Maximum allowable pulling tension on pulling device.

3.2.2 Duct Line

~~{Medium-voltage cables} {and Low-voltage cables} {Cables}~~ shall be installed in duct lines where indicated. ~~{Cable splices shall not be permitted, only in low-voltage cables splices shall be allowed only in very long runs per NEC. made in manholes and handholes only, except as otherwise noted.} {Cable joints in medium voltage cables shall be made in manholes or approved pullboxes only.}~~ Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

3.2.3 Insect and Rodent Damage

Animal guards shall be installed as required.

3.2.4 Electric Handholes

Cables shall be routed around the interior walls and securely supported from walls on cables racks. Cable routing shall minimize cable crossover, provide access space for maintenance and installation of additional cables, and maintain cable separation in accordance with IEEE C2.

3.3 FIREPROOFING

Each medium-voltage cable and conductor in ~~hand~~**manholes** shall be fire-proofed for their entire length within the ~~man~~**handhole**. Where cables and conductors have been lubricated to enhance pulling into ducts, the lubricant shall be removed from cables and conductors exposed in the manhole before fireproofing. ~~{Fire-stops shall be installed in each conduit entering or leaving a manhandhole.}~~

3.3.1 Tape Method

Before application of fireproofing tape, plastic tape wrapping shall be applied over exposed metallic items such as the cable ground wire, metallic outer covering, or armor to minimize the possibility of corrosion from the fireproofing materials and moisture. Before applying fireproofing tape, irregularities of cables, such as at cable joints, shall be evened out with insulation putty. A flexible conformable polymeric elastomer fireproof tape shall be wrapped tightly around each cable spirally in 1/2 lapped wrapping or in 2 butt-jointed wrappings with the second wrapping covering the joints of the first.

3.3.2 Sprayable Method

Manholes shall be power ventilated until coatings are dry and dewatered and the coatings are cured. Ventilation requirements shall be in accordance with the manufacturer's instruction, but not less than 10 air changes per hour shall be provided. Cable coatings shall be applied by spray, brush, or glove to a wet film thickness that reduces to the dry film thickness approved for fireproofing by FM P7825a. Application methods and necessary safety precautions shall be in accordance with the manufacturers instructions. After application, cable coatings shall be dry to the touch in 1 to 2 hours and fully cured in 48 hours, except where the manufacturer has stated that because of unusual humidity or temperature, longer periods may be necessary.

3.4 DUCT LINES

3.4.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 100 mm per 30 m. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 450 mm (18 inches) for ducts of less than 80 mm (3 inch) diameter, and 900 mm (36 inches) for ducts 80 mm (3 inches) or greater in diameter. Otherwise, long sweep bends having a minimum radius of 7.6 m shall be used for change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and

manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

3.4.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

3.4.3 Concrete Encasement

Ducts requiring concrete encasements shall comply with NFPA 70, except that electrical duct bank configurations for ducts 150 mm (6 inches) in diameter shall be determined by calculation and as shown on the drawings. The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point, except railroad and airfield crossings, tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. At railroad and airfield crossings, duct lines shall be encased with concrete and reinforced as indicated to withstand specified surface loadings. Tops of concrete encasements shall be not less than 1.5 m below tops of rails or airfield paving unless otherwise indicated. Where ducts are jacked under existing pavement, rigid steel conduit will be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For crossings of existing railroads and airfield pavements greater than 15 m in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 1.2 m on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 150 mm vertically.

3.4.4 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

3.4.4.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

3.4.5 Duct Line Markers

Duct line markers shall be provided ~~as indicated~~ and ~~at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures~~. In addition to markers, a 0.127 mm (5 mil) brightly colored plastic tape, not less than 75 mm (3 inches) in width and suitably inscribed at not more than 3 m (10 feet) on centers with a continuous metallic backing and a corrosion-resistant 0.0254 mm (1 mil) metallic foil core to permit easy location of the duct line, shall be placed approximately 300 mm below finished grade levels of such lines.

3.5 HANDHOLES, AND PULLBOXES

3.5.1 General

Handholes shall be constructed approximately where shown. The exact location of each handhole shall be determined after careful consideration has been given to the location of other utilities, grading, and paving. The location of each handhole shall be approved by the Contracting Officer before construction of the Handhole is started. Handholes shall be the type noted on the drawings and shall be constructed in accordance with the applicable details as indicated. Top, walls, and bottom shall consist of reinforced concrete. Walls and bottom shall be of monolithic concrete construction. The Contractor may at his option utilize monolithically constructed precast-concrete handholes having the required strength and inside dimensions as required by the drawings or specifications. In paved areas, frames and covers for handhole entrances in vehicular traffic areas shall be flush with the finished surface of the paving. In unpaved areas, the top of handhole covers shall be approximately 15 mm above the finished grade. Where existing grades that are higher than finished grades are encountered, concrete assemblies designed for the purpose shall be installed to elevate temporarily the handhole cover to existing grade level. All duct lines entering handholes must be installed on compact soil or otherwise supported when entering a handhole to prevent shear stress on the duct at the point of entrance to the handhole. Duct lines entering cast-in-place concrete handholes shall be cast in-place with the manhole. Duct lines entering precast concrete handholes through a precast knockout penetration shall be grouted tight with a portland cement mortar. PVC duct lines entering precast handholes through a PVC endbell shall be solvent welded to the endbell. A cast metal grille-type sump frame and cover shall be installed over the handhole sump. A cable-pulling iron shall be installed in the wall opposite each duct line entrance.

3.5.2 Electric Handholes

Cables shall be securely supported from walls by hot-dip galvanized cable racks with a plastic coating over the galvanizing and equipped with adjustable hooks and insulators. The number of cable racks indicated shall be installed in each handhole and not less than 2 spare hooks shall be installed on each cable rack. Insulators shall be made of high-glazed porcelain. Insulators will not be required on spare hooks.

3.5.3 Communications Handholes

The number of hot-dip galvanized cable racks with a plastic coating over the galvanizing indicated shall be installed in each telephone handhole. Each cable rack shall be provided with 2 cable hooks. Cables for the telephone and communication systems will be installed by others.

3.5.4 Pullboxes

Pullbox tops shall be flush with sidewalks or curbs or placed 15 mm above surrounding grades when remote from curbed roadways or sidewalks. Covers shall be marked "Low-Voltage" and provided with 2 lifting eyes and 2 hold-down bolts. Each box shall have a suitable opening for a ground rod. Conduit, cable, ground rod entrances, and unused openings shall be sealed with mortar.

3.5.5 Ground Rods

A ground rod shall be installed at the ~~manholes~~, handholes and pullboxes. Ground rods shall be driven into the earth before the ~~hand~~ manhole floor is poured so that approximately 100 mm of the ground rod will extend above the ~~manhand~~ manhole floor. When precast concrete manholes are used, the top of the ground rod may be below the ~~hand~~ manhole floor and a No. 1/0 AWG ground conductor brought into the ~~man~~ handhole through a watertight sleeve in the manhole wall.

3.6 PAD-MOUNTED EQUIPMENT INSTALLATION

Pad-mounted equipment, shall be installed on concrete pads in accordance with the manufacturer's published, standard installation drawings and procedures, except that they shall be modified to meet the requirements of this document. Units shall be installed so that they do not damage equipment or scratch painted or coated surfaces. After installation, surfaces shall be inspected and scratches touched up with a paint or coating provided by the manufacturer especially for this purpose. Three-phase transformers shall be installed with ~~phase sequence~~ in synchronization with system phase rotation. Primary taps shall be set at 13.8KV.

3.6.1 Concrete Pads

3.6.1.1 Construction

Concrete pads for pad-mounted electrical equipment ~~may be either pre-fabricated or~~ shall be poured-in-place. Pads shall be constructed as indicated, except that exact pad dimensions and mounting details are equipment specific and are the responsibility of the Contractor. Tops of concrete pads shall be level and shall project 100 mm above finished ~~floor~~ ~~paving or~~ grade and sloped to drain. Edges of concrete pads shall have 20 mm chamfer. Conduits for primary, secondary, and grounding conductors shall be set in place prior to placement of concrete pads. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves shall be installed through the concrete to provide physical protection. To facilitate cable installation and termination, the concrete pad shall be provided with a rectangular hole below the primary and secondary compartments, sized in accordance with the manufacturer's recommended dimensions. Upon completion of equipment installation the rectangular hole shall be filled with masonry grout.

3.6.1.2 Concrete and Reinforcement

Concrete work shall have minimum 20 MPa compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete pad reinforcement shall be in accordance with Section 03200 CONCRETE REINFORCEMENT.

3.6.1.3 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

3.6.2 Padlocks

Padlocks shall be provided for pad-mounted equipment ~~and for each fence gate. Padle~~ Padlocks shall be keyed [alike] [as directed by the Contracting Officer].

3.7 CONNECTIONS BETWEEN AERIAL AND UNDERGROUND SYSTEMS

Connections between aerial and underground systems shall be made as shown. Underground cables shall be extended up poles in ~~guards~~ or ~~conduit~~ to cable terminations. Conduits shall be secured to the poles by 2-hole galvanized steel pipe straps spaced not more than 3 m apart and with 1 strap not more than 300 mm from any bend or termination. Cable guards shall be secured to poles in accordance with the manufacturer's published procedures. Conduits shall be equipped with bushings to protect cables and minimize water entry. Capnut potheads shall be used to terminate medium-voltage multiple-conductor cable. Cables shall be supported by devices separate from the conduit or guard, near their point of exit from the conduit or guard.

~~3.8.1 Pole Installation~~

~~Pole installation shall be in accordance with Section 16370 ELECTRICAL DISTRIBUTION SYSTEM, AERIAL.~~

3.8 GROUNDING

A ground ~~mat~~ ~~ring~~ consisting of the indicated configuration of bare copper conductors and driven ground rods shall be installed ~~under~~ ~~around~~ pad-mounted equipment as shown. Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded. At least 2 connections shall be provided from ~~a transformer,~~ ~~a switchgear ground bus,~~ ~~and~~ ~~a unit substation~~ to the ground ring ~~mat~~. Metallic frames and covers of handholes and pull boxes shall be grounded by use of a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

3.8.1 Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

- Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 300 mm below finished grade.
- ~~Ground mat - A ground mat shall be installed as shown consisting of bare copper conductors installed {300} {450} {600} mm, plus or minus 75 mm, below the finished top of soil grade. Mat conductors shall be bonded to all rod electrodes, electrolytic electrodes, and to all other intersecting mat conductors. Mat conductors shall be sized as shown on the drawings.~~
- Ground ring - A ground ring shall be installed as shown consisting of bare copper conductors installed ~~{300} {450} {600}~~ mm, plus or minus 75 mm, below finished top of soil grade. Ground ring conductors shall be ~~{sized as shown}~~ {No. 2 AWG, minimum}.
- Additional electrodes - When the required ground resistance is not met, additional electrodes shall be provided ~~interconnected with grounding conductors~~ ~~as indicated~~ to achieve the specified ground resistance. The additional electrodes will be ~~up to three, {2.4} {3} m ({8} {10} feet) rods spaced a minimum of {3} {3.7} m apart~~ ~~or~~ ~~a single extension-type rod, {15.9} {19.1} mm ({5/8} {3/4} inch) diameter, up to 9.1 m (30 feet) long, {driven perpendicular to grade} {coupled and driven with the first rod}~~. In high ground resistance, UL listed chemically charged ground rods may be used. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Contracting Officer shall be notified immediately.

3.8.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

3.8.3 Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an

opening for the ground conductor, and the opening shall be sealed with a suitable compound after installation.

3.8.4 Surge Arrester Grounding

Surge arresters and neutrals shall be bonded directly to the transformer enclosure and then to the grounding electrode system with a bare copper conductor, sized as shown. Lead lengths shall be kept as short as practicable with no kinks or sharp bends.

3.8.5 Handhole, or Concrete Pullbox Grounding

Ground rods installed in handholes, or concrete pullboxes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 50 mm above and 150 mm below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to handhole walls and the amount of exposed bare wire shall be held to a minimum.

3.8.6 Metal Splice Case Grounding

Metal splice cases for medium-voltage direct-burial cable shall be grounded by connection to a driven ground rod located within 600 mm of each splice box using a grounding electrode conductor having a current-carrying capacity of at least 20 percent of the individual phase conductors in the associated splice box, but not less than No. 6 AWG.

3.8.7 Riser Pole Grounding

A single continuous vertical grounding electrode conductor shall be installed on each riser pole and connected directly to the grounding electrodes indicated on the drawings or required by these specifications. All equipment, neutrals, surge arresters, and items required to be grounded shall be connected directly to this vertical conductor. The grounding electrode conductor shall be sized as shown. Grounding electrode conductors shall be stapled to wood poles at intervals not exceeding 600 mm.

3.9 FIELD TESTING

3.9.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 30 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

3.9.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

3.9.3 Ground-Resistance Tests

The resistance of ~~each grounding electrode~~ or ~~each grounding electrode system~~ ~~the ground mat~~ **the ground ring** shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25 ohms.
- b. Multiple rod electrodes - 25 ohms.
- c. ~~Ground mat~~ ohms.
- d. Ground ring - 10 ohms.

~~3.11.4 Ground Mat Connection Inspection~~

~~All below grade ground mat connections will be visually inspected by the Contracting Officer before backfilling. The Contractor shall notify the Contracting Officer hours before the site is ready for inspection.~~

3.9.4 Medium-Voltage Cable Test

After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The test shall be conducted with all splices, connectors, and terminations in place. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 7 or NEMA WC 8 for the particular type of cable installed, except that 28 kV and 35 kV insulation test voltages shall be in accordance with either AEIC CS5 or AEIC CS6 as applicable, and shall not exceed the recommendations of IEEE Std 404 for cable joints and IEEE Std 48 for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

3.9.5 Low-Voltage Cable Test

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations of conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

$R \text{ in megohms} = (\text{rated voltage in kV} + 1) \times 304,800 / (\text{length of cable in meters})$

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

3.9.6 Liquid-Filled Transformer Tests

The following field tests shall be performed on ~~{all liquid-filled transformers}~~ {liquid-filled transformers 500 ~~{_____}~~ kVA and above}. Pass-fail criteria shall be in accordance with transformer manufacturer's specifications.

- a. Insulation resistance test phase-to-ground.
- b. Turns ratio test.
- c. Correct phase sequence.
- d. Correct operation of tap changer.
- e. ~~{_____}~~

3.9.7 Dry-Type Transformer Tests

The following field tests shall be performed on ~~{all dry-type transformers}~~ {dry-type transformer 15 ~~{_____}~~ kVA and above}. Pass-fail criteria shall be in accordance with the transformer manufacturer's specifications.

- a. Insulation resistance test phase-to-ground.
- b. Turns ratio test.
- e. ~~{_____}~~

3.9.8 Circuit Breaker Tests

The following field tests shall be performed on circuit breakers. Pass-fail criteria shall be in accordance with the circuit breaker manufacturer's specifications.

- a. Insulation resistance test phase-to-phase.
- b. Insulation resistance test phase-to-ground.
- c. Closed breaker contact resistance test.
- d. Power factor test.
- e. High-potential test.
- f. ~~{Manual}~~ ~~{or and}~~ {electrical} operation of the breaker.

3.9.9 Power Circuit Breaker Tests

The following power circuit breakers shall be tested in accordance with ANSI C37.50.

- a. ~~{_____}~~.
- b. ~~{_____}~~.
- e. ~~{_____}~~.

~~3.11.11 Protective Relays~~

~~Protective relays shall be visually and mechanically inspected, adjusted, tested, and calibrated in accordance with the manufacturer's published instructions. Tests shall include pick up, timing, contact action, restraint, and other aspects necessary to ensure proper calibration and operation. Relay settings shall be implemented in accordance with the coordination study. Relay contacts shall be manually or electrically operated to verify that the proper breakers and alarms initiate. Relaying current transformers shall be field tested in accordance with IEEE C57.13.~~

3.9.10 Operating Tests

After the installation is completed, and at such times as the Contracting Officer may direct, the Contractor shall conduct operating tests for approval. The equipment shall be demonstrated to operate in accordance with the requirements herein. An operating test report shall be submitted in accordance with paragraph SUBMITTALS.

3.10 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

-- End of Section --